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BULLETIN

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Vol. 45 No. 5

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1918

Studies in the genus Lupinus—III. Lupinus densiflorus

CHARLES PIPER SMITH

(WITH TEXT FIGURES 17–42)

Having, in my last paper, disposed of all the other species of the *Microcarpi*, I will confine this paper to my discussion and classification of *L. densiflorus* and its numerous varieties.

6. LUPINUS DENSIFLORUS Benth. Trans. Hort. Soc. II. 1: 410. 1835. [FIG. 17.]

The original description reads:

L. annuus, caulibus adscendentibus basi foliosus foliisque subsericeo-pilosis, foliolis oblongo-spathulatis, verticillis numerosis approximatis 6–10 floris, pedicellis ebracteatis, calycis labiis subintegris superiore membranaceo inferiore piloso duplo longiore, leguminibus villosis dispermis.

The flowers, which grow in distinct whorls, are white, delicately stained with pink, they are also a little speckled at the base of the vexillum. The leaves are closely clustered together, are covered with fine soft hairs, and each has about nine narrow divisions. The stem does not grow above six or seven inches high.

This species has hitherto produced its seeds, which are of an olive green, smooth, and minutely dotted with black, in very small quantity. It is probable that it requires shade.

In the same year Lindley, in the Botanical Register (**20**: *pl. 1689*), published a very interesting plate of *L. densiflorus* (see FIG. 17), and, in addition to quoting Bentham's description, gave a description of his own. From this I quote:

Annuus; caulo erecto . . . villoso, in spontanea pedunculo communi multo breviore . . . foliolis in spontanea pedunculo longioribus, culta brevioribus. . . . Verticilli villosissimi, 6–10 flori . . . approximati inferioribus magis distantibus. . . . Calyx villosus, in cultu tantum pubescens; bracteolis setaceis labii superioris longi-

[The BULLETIN for April (**45**: 133–166, *pl. 6*) was issued May 1, 1918.]

tudine; lab. sup. bipartito . . . intermedio minimo, superiore breviore. (Obs. partes in icone incuria pictoris false delineantur.) Vexillum lacteum, acutiusculum, basi viridi-punctatum; alae et carina acuminatae, roseae. . . . Semina olivacea, laevia, nigro maculata.

FIG. 17. LUPINUS DENSIFLORUS Benth. Copied from the original plate.

Lindley thus records his observation as to the differences between the specimens collected by Douglas in California and those grown in England from seed also collected by Douglas. While the plate may not be altogether satisfactory, it at least shows that the flowers were spreading in anthesis, and substantiates my conception of the species *sensu lato*.

About the same time Agardh saw the specimens in Lindley's herbarium and decided that there were at least two species. In his monographic "Synopsis Generis Lupini," also bearing the date of 1835, he described his *L. Menziesii* and made his own disposition of Bentham's species, without making mention of the specimens grown from seed. His two descriptions, in part, follow:

2. L. Menziesii nob. floribus in spica longissima verticillatis pedicellatis, pedicellis bracteas setaceas persistens subaequentibus, calycis ebracteolati labiis integris, superiore scarioso, inferiore herbaceo duplo longiore.

Hab. A Douglas e California reportatum. Vidi in Hb. Lindleyi.

Pedunculus terminalis longissimus (ultra pedalis) . . . subglaber, inferne pilis sparsis. . . . Foliola supra glabre, subtus pilosa. . . . Verticilli longe distantes, 5–6 flori. . . . Calyx ebracteolatus, pubescens, labio inferiore viridi, maximo, subinflato, superius scariosum, acuminatum plus duplo superante. Corollae luteae . . . carina valde curvata, apice ochracea. . . .

Singularis species primo aspectu corollis luteis verticillatis L. luteum referens; notis allatis tamen abunde diversa. Calyce singulari ad sequ. accedens, inter utramque collocanda videtur.

4. L. densiflorus Benth. floribus in spica densa verticillatis . . . bracteis persistentibus reflexis, corollam aequantibus, calycis ebracteolati labio sup. emarginato, inf. duplo longiore villosissimo tridentato.

L. densiflorus Benth. Hort. Trans. n. ser. v. I p. 409. Edwards Bot. Register. t. 1689.

Hab. E. California reportavit Douglas. Vidi in Hb. Lindl.

Habitus et fere characteres omnes praecedentis, sed robustior et villo longiore praecepue in partibus floralibus obsitus. . . . In speciminibus, quae coram habeo, differentia stipularum insignis; . . . Habitus etiam aliquantulum diversus, ita ut 2: as species hic latere, facile crediderum.

Agardh's treatment, perhaps because published in a monograph, was followed by Torrey and Gray in their Flora of North America; but Bentham (Pl. Hartweg. 303. 1848), some fifteen years after publishing his species, recorded a Monterey specimen thus:

1692 (53). *Lupinus densiflorus*, Ag.—Torr. & Gr. Fl. N. Amer. 1, p. 371, excl. syn. Benth.—In pascuis juxta Monterey.—Planta Douglasiana quam sub nomine L. densiflori olim descripsi est *L. Menziesii* Ag.—Torr. et Gr. Fl. N. Amer. 1, p. 371, quam etiam legit cl. Coulter inter San Miguel et Santa Barbara.

A few years later, Dr. Torrey (Pac. R. R. Report, 1853–4, Botany 4: 81. 1856) gave us the following views:

LUPINUS DENSIFLORUS, Benth. . . . Mr. Bentham (in Pl. Hartweg p. 303) points out that Agardh has founded his L. Menziesii upon the Douglasian plant, which he had described as L. densiflorus. All confusion about the synonymy may be avoided, however, for the two species, L. densiflorus and L. Menziesii, Ag., cannot be kept distinct. Both have white flowers (Agardh wrongly attributes yellow corollas to his L. Menziesii, but his guess from the appearance in dried specimens is not correct in this, nor in some other instances); and the longer bracts and very villous calyxes of Agardh's L. densiflorus are evidently not available for a specific distinction. Dr. Bigelow's specimens, however, correspond in this respect with L. Menziesii.

In Watson's review (Proc. Amer. Acad. 8: 538. 1873) the species is treated thus:

L. DENSIFLORUS, Benth. Much resembling the last [*L. microcarpus*], but more sparingly villous with shorter hairs; bracts much shorter than the calyx, which is smooth or short-pubescent, the upper lip often entire; petals yellow, or ochroleucous, white or pink.—From the Sacramento Valley southward. It includes *L. Menziesii*, Agh.; and *L. succulentus*, Koch, is probably but a garden form.

None of the writers quoted above may be credited with having done much field work in California, and it may be well to note here a mere gleaning from the writings of a Californian, Dr. Kellogg

of San Francisco, a man of extended field observations with a keen appreciation for plant differences. In his comments upon the plant named by him as *L. lacteus* (Proc. Cal. Acad. Sci. **5**: 38. 1873), he says:

> Admitting *L. densiflorus* to be the same as *L. Menziesii*, with variations, it would then bring us to a "dense subsessile spike" . . . with which to contend. . . . If these and many more varieties prove ultimately to run into one, it is not our fault; as the literature now stands, we are obliged, in self-defence, to set it apart, when called upon for determinations.

Agardh's descriptions are certainly more comprehensive than Bentham's, but the evidence is clear that the specimens selected by him for his description of *L. densiflorus* were not typical of the species as known to Bentham. The latter's statement, however, that *L. Menziesii* of Torrey & Gray is the same as his *L. densiflorus* may be worthy of some careful weighing. I agree with both Torrey and Watson that these two names do not represent two separate species; but Torrey's statement in respect to the "yellow corollas" in *L. Menziesii* is evidently erroneous, as attested by many herbarium specimens and by my own and others' field observations. I also appreciate Kellogg's observation that "these and many more varieties" exist, and feel, as he felt, the need of a classification for their naming.

Very little can be gleaned from the published records of Douglas's sojourn in California. In his letter dated "Nov. 23rd 1831," written from "Monterey, Upper California" and published by Dr. Hooker (Comp. Bot. Mag. **2**: 149. 1836), he states that he arrived at Monterey on December 22, 1830. About the end of April, after various short excursions out of Monterey, he "undertook a journey southward, and reached Santa Barbara, 34° 25′, in the middle of May . . . and returned late in June, by the same route. . . . Shortly afterwards [he] started for San Francisco, and proceeded to the North of that port." His "last observation was at 30° 45′"; therefore in what is now Sonoma County, or possibly, but not probably, in Solano or Yolo County.

Study of the collectors' data with the numerous specimens examined by me while preparing this paper permits of some speculations that may be worthy of attention. One might thus conclude that Douglas's specimens were secured before leaving

Monterey for the north. Mature seed, however, might have been taken by him almost anywhere from Santa Barbara to Sonoma County. The "type" of Agardh's *L. Menziesii* probably came from San Luis Obispo County, while the "type" of *L. densiflorus* Agardh almost certainly came from the vicinity of Monterey. *L. densiflorus* Benth., however, was based upon specimens grown from seed collected by Douglas. The seed characters given by both Bentham and Lindley ought to be useful; but, unfortunately, the seeds of most of the varieties herein recognized are unknown, and none of those seen help much in the study from this angle. Therefore, what may be accepted as reliable diagnostic seed characters are yet to be worked out.

To sum up:—It seems to be an easy matter to establish the identity of *L. densiflorus* Benth., when such is recognized as a composite of numerous variable forms; but it is certainly a much more difficult matter to determine which of the several forms is properly to be designated as the typical plant. None of the varieties herein considered are known to combine a low stem six or seven inches high with pink-veined white petals and seeds smooth, olive-green, and minutely dotted with black. For the present, however, to serve as the typical form of the species, I am accepting a Sonoma County plant whose inflorescence, flower-color, and pubescence agree fairly well with Bentham's description and the plate in the Botanical Register, and whose period of blossoming at Santa Rosa, June 2, as found by Heller, would have permitted the collecting of seed by Douglas at the time of his visit to that region.

The following key will probably be useful in determining most of the material in the larger herbaria in terms of the varieties recognized in this paper. Undoubtedly additional varieties are yet to be added to the list.

Key to the varieties of Lupinus densiflorus

Calyx not bushy-villous below, the hairs 0.3–1.5 mm. long, bracteoles frequently present.

Pubescence of stems and peduncles usually less than 1 mm. long, rather dense and subappressed or sparse and closely appressed; lower calyx-lip usually distinctly subsaccate and bent near base. DENSIFLORI.

Leaflets thin or thickish, not blackening in drying.

Simple or branched well above the base, foliage mostly open.
Calyx 7–8 mm. long; petals not yellow.
Banner 8 mm. wide; lower calyx-lip acute, the two teeth slender and parallel. 6*a*. typical *densiflorus*.
Banner 6 mm. wide; lower calyx-lip with broad sinus and a vestigial tooth. 6*b*. var. *stenopetalus*.
Calyx 9–12 mm. long; petals often yellow.
Flowers 16–19 mm. long; calyx 11–12 mm. long; banner 15–17 mm. long; petals usually not yellow, often rose-tinted. 6*c*. var. *perfistulosus*.
Flowers 13–15 mm. long; calyx 9 (rarely 10) mm. long; banner 14 mm. long; petals evidently yellow, often reddish- or purplish-tinged at the edges. 6*d*. var. *Menziesii*.
Much branched at or near the base, the foliage congested.
Calyx bracteolate; lower lip obtuse, the teeth broad and diverging; petals drying a dark rose-purple. 6*e*. var. *latilabrus*.
Calyx ebracteolate, lower lip acutish, the teeth small and parallel; petals drying a rich blue. 6*f*. var. *Tracyi*.
Leaflets almost succulent, blackening in drying; calyx bracteolate, lower lip acute and entire or minutely two- to three-toothed. 6*g*. var. *glareosus*.
Pubescence of stems and peduncles 1–1.5 mm. long, spreading or retrorsely spreading.
Lower calyx-lip nearly straight, inconspicuously or not at all subsaccate and bent near base. LACTEI.
Acaulescent or nearly so, commonly simple with the central peduncle elongated.
Keel nearly straight; banner rather abruptly contracted into a well-defined claw. 6*h*. var. *lacteus*.
Keel evidently curved; banner gradually contracted into a poorly defined claw. 6*l*. var. *vastiticola*.
Stems and branches elongated, the branches usually all floriferous.
Flowers 14–16 mm. long; banner 15–16 mm. long; calyx hairs conspicuously retrorse-spreading, about 1 mm. long. 6*i*. var. *sublanatus*.
Flowers 12–14 mm. long; banner 11–14 mm. long.
Calyx 7 mm. long; banner rather abruptly contracted into a well-defined claw; keel nearly straight. 6*j*. var. *McGregori*.
Calyx 8 mm. long; banner gradually contracted into a poorly defined claw; keel evidently curved. 6*k*. var. *altus*.
Lower calyx-lip usually distinctly subsaccate and bent near base; flowers 13–19 mm. long, banner 13–16 mm. long, calyx 8–10 mm. long. VERSABILES.

Branches ascending to suberect; whorls five to several.
Calyx commonly bracteolate, the hairs mostly 0.3–0.5 mm. long.
Calyx 10 mm. long, lower lip acutish, the teeth not broader than long. 6m. var. *versabilis*.
Calyx 8–9 mm. long, lower lip obtuse, the teeth broader than long. 6n. var. *latidens*.
Calyx rarely bracteolate, the hairs mostly 1.5 mm. long. 6o. var. *Dudleyi*.
Branches short and widely spreading; whorls two to five; flowers and fruits conspicuously secund. 6p. var. *persecundus*.
Calyx bushy-villous below, the hairs 1.5–4 mm. long, ebracteolate. PALUSTRES.
Lower calyx-lip usually distinctly bent and inflated near base.
Flowers 13–14 mm. long; calyx 8 mm. long.
Lower lip two-toothed; keel slender; plants 30–60 cm. tall. 6t. var. *curvicarinus*.
Lower lip three-toothed; keel stout; plants low. 6u. var. *Reedii*.
Flowers 15–17 mm. long; calyx 9–12 mm. long.
Plants low, 8–15 cm. tall, the stems and branches short and usually widely spreading. 6s. var. *crinitus*.
Plants mostly erect, 20–60 cm. tall.
Banner rounded or truncate at apex; lower lip of calyx two-toothed, the middle tooth vestigial or wanting. 6q. var. *palustris*.
Banner acute or distinctly contracted apically; calyx three-toothed. 6r. var. *stanfordianus*.
Lower calyx-lip straight or nearly so, indistinctly or not at all bent and subsaccate near base.
Banner rounded or truncate at apex, 6 mm. wide; calyx 8–9 mm. long, two-toothed; plant densely villous. 6v. var. *trichocalyx*.
Banner mostly angled at apex.
Banner 11 mm. long, 5 mm. wide; calyx 8 mm. long, lower lip three-toothed, upper lip less than 2 mm. long. 6w. var. *barbatissimus*.
Banner 12–15 mm. long; calyx 10–13 mm. long, upper lip usually 3–4 mm. long.
Banner gradually contracted into an undifferentiated claw; wings naked or nearly so. 6y. var. *scopulorum*.
Banner contracted into a well-defined broad claw; wings ciliate at the upper basal angle.
Lower lip distinctly three- (rarely four-) toothed; leaflets conspicuously ciliate on the margins and midrib below. 6r. var. *stanfordianus*.
Lower lip two-toothed, the median tooth vestigial or wanting; leaflets not conspicuously ciliate. 6x. var. *austrocollium*.

DENSIFLORI

6*a*. LUPINUS DENSIFLORUS Benth. (typical).

Pubescence less than 1 mm. long; verticils six to nine; calyx about 8 mm. long, with short inconspicuous appressed pubescence, lower lip barely 3 mm. wide, acute, the two slender teeth with a very narrow sinus; petals white, tinted or veined with violet or rose, banner 14 mm. long, 8 mm. wide, keel 12 mm. long, relatively slender. Seed not seen.

FIG. 18. LUPINUS DENSIFLORUS Benth. *A. A. Heller 5630* (US 416650).

CALIFORNIA. Sonoma County: Santa Rosa, 2 June, 1902, *A. A. Heller 5630* (DS, US, PA, NY, G). Napa County: Conn Valley, Napa River Basin, 1 May, 1894, *W. L. Jepson* (UC). Santa Clara County: Stanford University, 5 May, 1895, *Cloud Rutter 173* (UC 308269, middle and right-hand specimens only). County not given: Taylor Mountain, 20 Apr., 1898, *M. S. Baker* (UC).

6*b*. **Lupinus densiflorus stenopetalus** var. nov. [FIG. 19.]

Vexillo gracillimo, 13–14 mm. longo, 6 mm. lato, ungue gracili prope 2 mm. lato, contracto; calyce 8 mm. longo, labio inferiore bidentato, sinu lato dentis vestigio instructo, dentibus curvis; semina non vidi.

Petals white, more or less rose-purple edged, the banner unusually narrow, about 6 mm. wide, with the claw only 2 mm. wide; lower lip of the calyx two-toothed, the teeth curved and a vestigial median tooth usually present. Seed not seen.

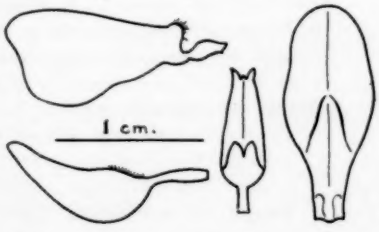

FIG. 19. LUPINUS DENSIFLORUS STENOPETALUS C. P. Smith. *A. A. Heller 7385* (US 468403).

CALIFORNIA. Santa Clara County: Los Gatos, 7 May, 1904, *A. A. Heller 7385* (TYPE, US 468403; type-duplicates, PA, NY, G). San Mateo County: San Francisquito Canyon, 27 May, 1905, *F. Grinnell* (US).

Stenopetalus, Greek for "slender petal," refers to the very narrow banner.

6*c*. **Lupinus densiflorus perfistulosus** var. nov. [FIG. 20.]

Ramosus plerumque aliquantum super basin quamquam interdum eramosus, 25–60 cm. altus; caule manifeste et ramis pedunculisque plus minusve fistulosis, minute laxe pubescentibus vel levibus; foliis patentibus; petiolis longissimis, 10–20 cm. longis; foliolis 6–10, 20–40 mm. longis, oblanceolatis acutis arcuatis paulo dense appresso-pubescentibus vel levibus subter; pedunculis elongatis, plerumque folia excedentibus; verticillis plurimum 6–12 vel pluris, appositis vel distantibus subter; floribus pandentibus,

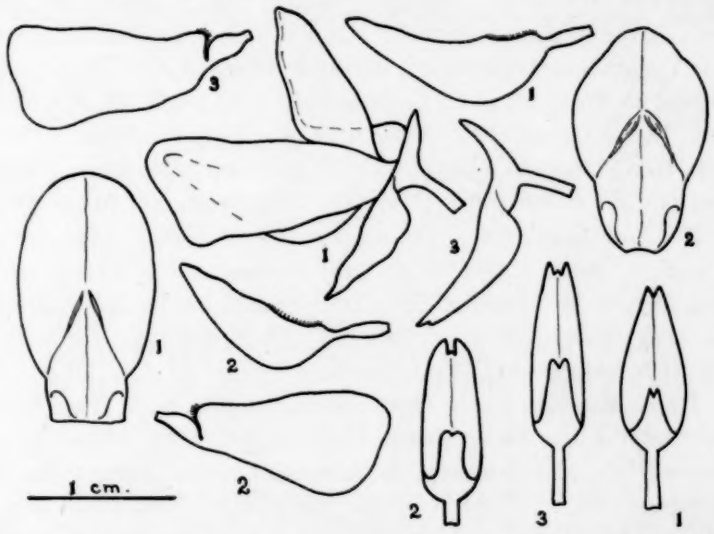

FIG. 20. LUPINUS DENSIFLORUS PERFISTULOSUS C. P. Smith. 1. *Heller & Brown 5376* (US 413708); 2. *W. H. Brewer 483* (US 321138); 3. *Heller & Brown 5381* (US 413713).

15–19 mm. longis; pedicellis 3–4 mm. longis, prope 1 mm. latis; bracteis humillimis 12–15 mm. longis, breve-pubescentibus vel levibus; calyce 11–12 mm. longo, ebracteolato, appresso-pubescenti vel levi, labio superiore 2–4 mm. longo, emarginato, inferiore manifeste inflato, prope 4 mm. lato, 2-dentato, sinu gracili vel latiore dentis vestigio instructo; petalis diverse roseo- vel purpureotinctis, interdum luteis; vexillo 15–17 mm. longo, 9 mm. lato, apice rotundato paullatim contracto in unguem rigidum inflatum 5–6 mm. latum saepe retrorse dilatatum, labium superiore calycis repellentem; alis 13–15 mm. longis, ad basin superne ciliatis, 7 mm. latis, apicibus conspicue truncatis; carina 11–14 mm. longa, manifeste arcuata: legumina seminaque non vidi.

The most robust and largest-flowered variety of the species, unless equalled by var. *palustris;* often 60 cm. tall, stem usually fistulose; flowers 15–19 mm. long, banner 15–17 mm. long, rounded at the apex, the claw inflated and stiff, sometimes pushing back the upper calyx-lip, wings conspicuously truncate at the apex, lower calyx-lip strongly subsaccate and bent downward; pods and seeds, probably the largest of the species.

CALIFORNIA. County not given: 1868–9, *Kellogg & Harford 187* (TYPE, US 20645). Solano County: near Fairfield, 26 Apr., 1902, *Heller & Brown 5376* (US, G, NY, DS, PA); Gates Canyon, near Vacaville, 27 Apr., 1902, *Heller & Brown 5381* (US, PA, G); Vallejo, 11 May, 1874, *E. L. Greene 171* (G); Wolfskill, 2–6 May, 1891, *W. L. Jepson* (UC). Contra Costa County: Muir Station, July, 1904, *Charlotta Case* (UC). Yolo County: Rumsey, 7 May, 1903, *C. F. Baker 3070* (US, G); Woodland, 16 May, 1893, *J. W. Blankinship* (G), Butte County: "fields," May, 1898, *Mrs. C. C. Bruce 2033* (NY). Lake County: Burns Valley, Apr., 1902, *Agnes M. Bowman 146* (DS). San Luis Obispo County: San Luis Obispo, 27 Apr., 1861, *W. H. Brewer 483*, Geol. Sur. Cal., (US); May, 1893, *Mrs. Blochman* (UC).

Two other specimens that perhaps should have been listed above are: Little Oak, Solano County, 2–6 May, 1891, *W. L. Jepson* (UC), and Brighton, Sacramento County, Apr., 1884, *K. Brandegee* (UC). These, and also the Contra Costa plant listed, have a much denser pubescence than I have attributed to this variety and would probably not be easily traced here by the use of the key on pages 171–173. The last-mentioned plant is also a pathological individual, having leafy branches and one raceme developed from raceme-buds that normally should have produced flowers. Seeds with Jepson's "Little Oak" specimen are dull yellowish brown, finely and sparsely speckled with dark brown, 6 x 5 mm., decidedly flattened.

6*d*. **Lupinus densiflorus Menziesii** (Agardh) comb. nov. [FIG. 21.]

Lupinus Menziesii Agardh, Syn. Gen. Lup. 2. 1835.

Lupinus Menziesii aurea Kell. Proc. Cal. Acad. Sci. **5**: 16. 1873.

Agardh's description will be found on page 168, included in my

general discussion of *L. densiflorus*, so will not be repeated here. The description of Kellogg's variety is as follows:

Collected by Kellogg and Samuel Brannan, Jr., in Deer Valley, near Antioch, San Joaquin River, April 22d, 1869; chiefly differing from the accepted description of the species—if we include also *L. densiflorus*—in the 2-toothed lower lip, relative length of leaves, and the entire scarious tube of the calyx, etc.

Stem fistulose, branching from near the axi[a]l summit, leaflets about 10, one third the length of the petiole, glabrous above, pubescent beneath, stipules and bracts scarious, setaceously long acuminate, persistent; calyx tube scarious, upper lip 2-toothed, deflexed, somewhat saccate; vexillum short, rounded outline, pubescent on the back at the base, and along the claw above. Legumes hirsute, minute, 2-seeded.

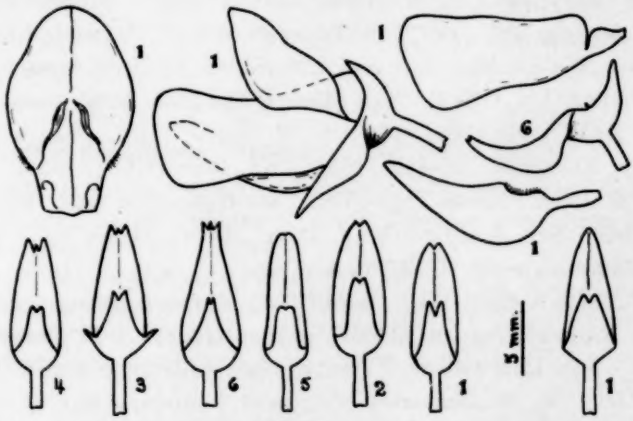

FIG. 21. LUPINUS DENSIFLORUS MENZIESII (Agardh) C. P. Smith. 1. *C. P. Smith 1456*; 2. *A. A. Heller 7311* (US 468336); 3. *A. A. Heller 7439* (US 468453); 4. *C. P. Smith 1484*; 5. *A. D. E. Elmer 4791* (US 665678); 6. *H. A. Walker 2526* (US 669625).

As I have stated in the foregoing pages, I agree with others that *L. Menziesii* is not specifically distinct from *L. densiflorus;* but, on the other hand, I consider it a readily recognizable variety, from which I do not feel justified in trying to separate Kellogg's var. *aurea*. The following description is supplementary to those given by others:

Flowers 14–15 mm. long; calyx rarely (*Heller 7439*) bracteolate, commonly 9 mm., rarely 10 mm. long, upper lip variable in form, 2.5–3.5 mm. long, lower lip acute or rounded at the tip and entire or two- to three-toothed, the teeth mostly less than 1 mm. long; petals bright yellow or paler, the apices and margins often washed with some shade of reddish purple; banner 12–14 mm. long, 7–8 mm. wide, rather abruptly contracted into a claw 4 mm. wide;

wings 11–12 mm. long, 6 mm. wide; pods conspicuously secund; seeds about 4.5 x 4 mm. long, yellowish brown, speckled with darker brown, the dark "lateral lines" enclosing a paler area about the hilum, plump or somewhat flattened.

CALIFORNIA. County not given: *D. Douglas* (T, G); *T. Bridges 59* (T, Col. U, NY, G, US). Sacramento County: Elk Grove, May, 1882, *E. R. Drew* (UC). Contra Costa County: Port Costa, 8 June, 1892, *T. S. Brandegee* (DS, NY); Antioch, 3 May, 1893, *A. Eastwood* (G); Antioch, 5 May, 1907, *K. Brandegee* (UC 155195, as to specimen in center of sheet); near Point Isabel, 8 July, 1911, *H. A. Walker 2526* (US, G). Marin County: Ross Landing, Aug., 1877, *H. Edwards* (NY). Alameda County: between Mission San Jose and Livermore, 13 Apr., 1904, *A. A. Heller 7311* (US, UC, PA, G); Mission San Jose, June, 1909, *R. J. Smith 7* (UC); Oakland, 1875, *G. R. Vasey* (US). Santa Clara County: Evergreen, 11 Apr., 1893, *J. B. Davy* (UC); Gilroy, May, 1903, *A. D. E. Elmer 4791* (US); Mt. Hamilton road, fourteen miles from San Jose, 20 May, 1904, *A. A. Heller 7439* (US); Mt. Hamilton road, Halls Valley, 1950 ft. alt., 17 June, 1908, *C. P. Smith 1484* (CPS). Santa Cruz County: along Southern Pacific Railway, east of Ellicott, 4 June, 1908, *C. P. Smith 1456* (CPS). San Luis Obispo County: open hills near sea, 1 Mar., 1883, *Mrs. R. W. Summers* (G); near boundary line of Santa Barbara County, 8 May, 1896, *A. Eastwood* (G); Newhall Ranch, 8 May, 1900, *J. H. Barber* (G).

6*e*. **Lupinus densiflorus latilabrus** var. nov. [FIG. 22.]

Caule ad basin ramoso, ramulis foliisque congestis; foliolis 5–8, 10–25 mm. longis, 2–3 mm. latis; verticillis 3–5, floribus 13–15 mm.

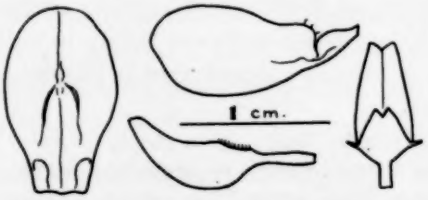

FIG. 22. LUPINUS DENSIFLORUS LATILABRUS C. P. Smith. *E. Braunton 1081* (US 469834).

longis, pedicellis brevibus; calyce bracteolato 8 mm. longo, pilis subappressis 0.5 mm. longis, labio inferiore 4 mm. lato apice obtuso

2-dentato, dentibus latis brevibusque, sinu brevissimo; petalis ad dimidia terminata roseo-purpureis, ad basin pallidis; vexillo prope 12 mm. longo, 8 mm. lato, apice rotundato; alis 11 mm. longis, vix ciliatis ad basin superne; carina 9–10 mm. longa, paulo curvata; leguminibus prope 14 mm. longis; semina matura non vidi.

Differs from var. *Menziesii* in the stem being branched at the base, the branchlets and foliage congested; whorls few and pedicels short and stout; calyx with bractlets, the lower lip relatively wide at the blunt apex, the two teeth short and wide; keel not much curved; terminal half of petals a dark rose purple when dried.

CALIFORNIA. Amador County: vicinity of Ione, 200–500 ft. alt., June, 1904, *E. Braunton 1081* (TYPE, US 469834; type-duplicates, NY, UC).

Latilabrum is Latin for " broad lip."

6*f*. **Lupinus densiflorus Tracyi** var. nov. [FIG. 23.]

Caule ramosissimo ad basin foliis congestis; labio inferiore calycis apice acuto bidentato, dentis sinuque gracilibus; petalis pallido-carnosis, ad anthesin atro-caeruleis cum siccatis; vexillo 12 mm. longo, 8 mm. lato, ungue non claro; alis carinaque latis: legumina seminaque non vidi.

Much branched at the base with the foliage congested; lower calyx-lip acute, the two teeth and their sinus narrow; petals pale flesh-colored when fresh (according to the label), largely a rich blue in the preserved specimen; banner 12 mm. long, 8 mm. wide, the claw not well defined; wings and keel relatively broad.

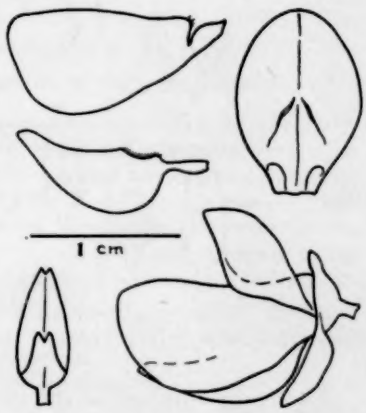

FIG. 23. LUPINUS DENSIFLORUS TRACYI C. P. Smith. *J. P. Tracy 3280* (UC 161546).

CALIFORNIA. Humboldt County: gravel bar of Willow Creek, Trinity River Valley, 4 July, 1911, *J. P. Tracy 3280* (TYPE, UC 161546), labelled " *L. microcarpus*."

6g. **Lupinus densiflorus glareosus** (Elmer) comb. nov. [FIG. 24.]
Lupinus glareosus Elmer, Bot. Gaz. **39**: 53. 1905.

I quote from Elmer's description, as follows:

An almost acaulescent annual, 3–5 dm. high, somewhat succulent though readily curing: stem very short, rather thick and hollow, terminated by a spicate inflorescence; branches with a soft short brownish pubescence, chiefly from the stem, the outer ones curved upwards from the middle . . . leaflets 10 . . . sparsely pubescent on both sides, soft and fleshy . . . the older ones with a very peculiar dead scarious margin: spikes cylindrical . . . 10–15 cm. long, erect and exceeding the leaves . . . flowers in whorls of 5, upon short pubescent pedicels . . . calyx . . . pubescent; lower lip rather broad, 7 mm. long, obtuse, 3-nerved; upper one thinner, 3 mm. long, notched; banner broadly elliptic, 12 mm. long . . . keel at least 12 mm. long, falcate . . . with the margin of the aperture densely ciliate . . . seeds . . . smooth, compressed.

Griffin's Postoffice, Ventura County, California, July, 1902. Type specimen, no. 3588, in Herb. Stanford University.

It is wholly confined to dry gravelly soil along water courses, hence its name.

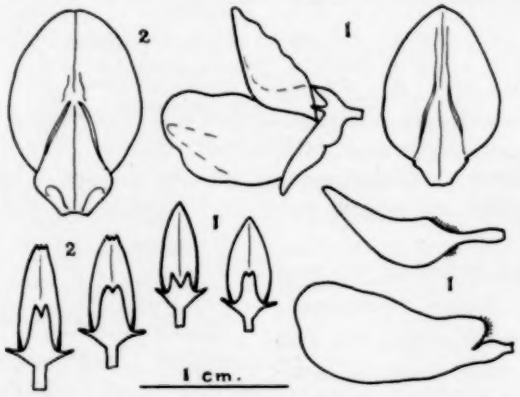

FIG. 24. LUPINUS DENSIFLORUS GLAREOSUS (Elmer) C. P. Smith. 1. *A. D. E. Elmer 3588* (US 465791); 2. *Abrams & McGregor 262* (US 613146).

I consider this one of the most extreme variations of *L. densiflorus*, and I would have upheld it as a species but for the evidence presented by Abrams & McGregor's collection listed below. The following characters should also be mentioned.

Foliage blackening in drying; verticils crowded or distinct, six to twelve or fewer; flowers spreading in anthesis, becoming secund later, 13–14 mm. long; calyx bracteolate, 6.5–8 mm. long, very shortly and almost sparsely appressed-pubescent, upper lip a little more than 1 mm. long and cleft, or 2–3 mm. long and emarginate, lower lip entire and acute or minutely three-toothed, about 3 mm.

wide; petals (according to Dr. Hall's labels) light blue, the banner with a white center; banner 12–14 mm. long, 8–9 mm. wide, ovate to "broadly elliptic," obtusely angled, truncate, or rounded at the apex, the basal inflation much thickened and stiff; seeds pale yellowish brown, sparsely mottled with dark brown, the considerably paler hilum area marked off by prominent V-shaped lines.

CALIFORNIA. Ventura County: Griffin's Postoffice, June, 1902, *A. D. E. Elmer 3588* (DS, US, NY); Griffin, Mt. Pinos, 20 June, 1905, *H. M. Hall 6334* (G, UC); near Frazier borax mine, Mt. Pinos, 12–14 June, 1908, *Abrams & McGregor 262* (DS, US).

While with his description Elmer gives the date of collection of his number 3588 as July, 1902, his labels give June as the month. His number 4006, however, from the same locality, is labeled as having been taken in July; but the latter is a very different plant, and has been treated by me elsewhere as *L. subvexus nigrescens* (Bull. Torrey Club **45**: 13. 1918).

LACTEI

6*h*. **Lupinus densiflorus lacteus** (Kell.) comb. nov. [FIG. 25.]

Lupinus lacteus Kell. Proc. Cal. Acad. Sci. **5**: 37. 1873.

Lupinus arenicola Heller, Muhlenbergia **2**: 75. 1905.

Kellogg's description of *L. lacteus* is, in part, as follows:

Stem annual, fistulous, the elongated central peduncle from a mere depressed crown, mostly solitary, spike 4 to 8 inches long, lateral radicle branches 2 to 6 inches long, with secondary clusters of leaves and (when present) shorter spikes, soft pubescent throughout, with white hairs. Leaves mostly clustered at the base . . . leaflets . . . silky-pubescent beneath. . . . Flowers large, white, somewhat distant, verticillate . . . calyx ebracteolate, hirsute . . . upper lip 2-cleft (rarely entire) about ⅓ the length of the lower lip, lower lip straight, herbaceous, 2-toothed . . . vexillum . . . ciliate at the marginal juncture of the claw . . . banner, wings and keel about equal, wings oblong . . . margins ciliate at the base or origin of the claw; keel ciliate at the upper inside margin toward the base.

In habit and general appearance this species resembles *L. brevicaulis*, but is rather more robust, the flowers much larger and not "deep blue," but quite *white*, . . . It is closely allied to *L. Menziesii*. . . . Specimens collected by Mr. S. Brannan, Jr., on Oak Creek hillsides, Kern County, 14 miles from Tejon Pass.

Extracts from Heller's description of *L. arenicola* follow:

Branches several, ascending, commonly only the middle one floriferous . . . flowers in 1 to 3 whorls, merely ascending, whitish or rose color, 1.5 cm. long . . . calyx with broad acutish lower lip 7 mm. long, 5 mm. wide at base, the apex minutely 2-toothed; upper lip ovate . . . the apex 2-toothed, the teeth 1 mm. long, slightly spreading; banner turned back . . . keel . . . little curved, ciliate on the lower half, . . . seeds large, 4 mm. in diameter, white or whitish.

The type is no. 7609, collected April 7, 1905, near the first crossing of the creek west of Caliente, Kern county, California, growing in sandy soil on steep banks near the railroad. It also occurs on the bluffs of Kern River above Bakersfield.

Heller, writing some five years later (Muhlenbergia **6**: 70. 1910), says:

It gives me great pleasure to reinstate this long unrecognized species [*L. lacteus*], even at the expense of one of my own names. The species was barely published before it was suppressed by Watson in Proc. Am. Acad. 8: 542, November, 1873. He there puts it down as a synonym of *L. densiflorus*, but evidently never saw the plant itself, for he does not mention it in the list of specimens examined. During the course of five years he came to another conclusion, for in the Bibliographical Index, published in 1878, it is said to be the same as *L. microcarpus*, a less satisfactory disposition than the first, for it is clearly more related to *L. densiflorus* than it is to the narrow-flowered *L. microcarpus*.

The type of *L. arenicola* shows a bractlet in the sinus between the calyx lobes, whereas Kellogg says it is not present.

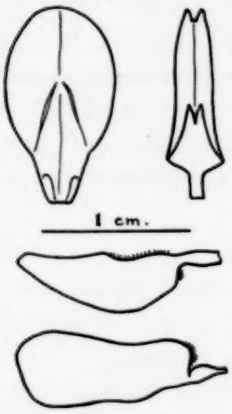

FIG. 25. LUPINUS DENSIFLORUS LACTEUS (Kell.) C. P. Smith. *C. A. Purpus 5301* (US 328676).

CALIFORNIA. Kern County: near Caliente, *A. A. Heller 7609* (US, G, NY, PA); Bakersfield, 26 Apr.–30 May, 1896, *J. B. Davy 1716* (G). Ventura County: Ojai and vicinity, 25 Apr., 1866, *S. F. Peckham* (US); Ojai Valley, 18 Apr., 1896, *F. W. Hubby 34* (UC). Tulare County: North Tule River, May, 1896, *C. A. Purpus 1733* (UC); North Tule River, May–Oct., 1896, *C. A. Purpus 5694* (UC); "Southeastern Cal."; hillsides, Erskin Creek, Apr.–Sept., 1897, *C. A. Purpus 5301* (US, G, UC). Riverside County: near San Jacinto, 9 Mar., 1898, *J. B. Leiberg 3134* (US). San Diego County: Coyote Canyon (Colorado Desert), Apr., 1902, *H. M. Hall 2853* (UC).

While not recognizing *L. lacteus* as of specific rank, I accept it as a well-marked variety of *L. densiflorus*. As to the calyx bracteoles, the discrepancy between Kellogg's and Heller's descriptions is not a critical point, for my studies have shown me that these bractlets may or may not be present in different flowers of a particular raceme. I find them to be usually absent in the specimens listed above. The pubescence in this variety is quite variable, some specimens being nearly smooth.

Kellogg's Napa specimen in the Gray Herbarium (Napa, dry barren hillsides, 1 Apr., 1870), though distributed by Kellogg as *L. lacteus*, cannot be referred here. It is possibly a diminutive specimen of var. *perfistulosus* of this paper.

6*i*. **Lupinus densiflorus sublanatus** var. nov. [FIG. 26.]

Erectus, eramosus vel ramosus, 10–40 cm. altus, caule et cetera dense conspicueque villoso, pilis plusculum 1 mm. longis: bracteis calycibusque saepe sublanatis: verticillis 5–9; floribus pandentibus ad anthesin et postea: calyce bracteolato vel ebracteolato, labio superiore 3–4 mm. longo, gracile, acuto integroque vel bifido, inferiore recto vel ad basin paulo inflato 2-dentato, dentibus 1 mm. longis parallelis, sinu cum vestigio vel sine eo: corolla alba vel tincta; vexillo 13–15 mm. longo, 7–9 mm. lato, apice rotundato vel interdum obtuse angulato; alis superne ad basin ciliatis, interdum subter paulo; carina recta vel curva: fructus seminaque non vidi.

CALIFORNIA. Kern County: Water Canyon, Tehachapi Mountains, 26 June, 1908, *Abrams & McGregor 485* (TYPE, DS 9584; type-duplicates, US, NY, G); Tehachapi, June, 1911, *K. Brandegee* (UC); vicinity of Fort Tejon, 16–17 June, 1908, *Abrams & McGregor 310* (DS, US, NY, G); vicinity of Fort Tejon, 1857–8, *L. J. X. de Vasey 21* (US); Tehachapi, 1891, *Coville & Funston 1119* (*F. W. Koch*) (US); Bakersfield, 26 Apr.–30 May, 1896, *J. B. Davy 1708* (UC); Keene Station, 1 May, 1905, *A. A. Heller 7798* (DS, US, PA, G, NY); vicinity of Havilah, 15 June, 1905, *F. Grinnell 295* (US); Johnson Canyon, Walker Basin, 3 June, 1905, *F. Grinnell 51* (US); Caliente Creek, 1 June, 1905, *F. Grinnell 4* (US); near Caliente, May, 1909, *K. Brandegee* (UC).

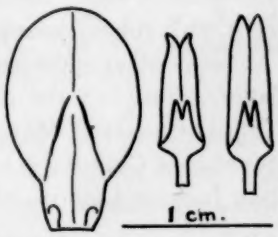

FIG. 26. LUPINUS DENSIFLORUS SUBLANATUS C. P. Smith. *Abrams & McGregor 485* (DS 9584).

Probably most closely related to var. *lacteus*, from which it would seem to be easily distinguished by the caulescent habit and the numerous racemes. It is noteworthy, however, that most of the specimens cited above were collected in June, while the types of both *L. lacteus* and *L. arenicola* were taken in April. It would therefore be an interesting study for some student to locate, if possible, the type station of Heller's *L. arenicola* and Mrs. Brande-

gee's station at Tehachapi, say in April, and follow both through until all the seed is matured and the season's growth is evidently completed. Cultural studies would also be of interest; but great care would be very necessary in the selection and identification of the seed to be used.

Sublanatus, "almost woolly," refers to the general pubescence of the typical phase of the variety, as represented by the type-collection and Mrs. Brandegee's Tehachapi plant. However, the specimens referred here show quite a range of variation in density of pubescence, the "least lanate" extreme being well represented by Abrams & McGregor's No. 310. This collection I had selected as the type of an additional variety, but later decided that this variation was not supported by other characters and, evidently, was in itself too inconstant to be reliable. In the upper San Joaquin Valley, as at Bakersfield, where the two varieties overlap, the nearly straight lower calyx-lip with retrorse-spreading hairs should readily distinguish var. *sublanatus* from the related var. *versabilis*, in which the lower lip is decidedly subsaccate and pubescent with subappressed hairs about 0.5 mm. long.

Some other specimens, not placed elsewhere, which may have some affinity to the above are: Nacimiento Canyon, San Luis Obispo County, 8 May, 1900, *J. H. Barber* (UC); Knights Ferry, Stanislaus County, 9 Apr., 1895, *F. W. Bancroft* (UC); Linden, San Joaquin County, May, 1896, *F. W. Gunnison* (UC).

6*j*. **Lupinus densiflorus McGregori** var. nov. [FIG. 27.]

Erectus, super basi prope 10 cm. ramosus, ramis paucis suberectis, caule ramisque gracilibus nequaquam fistulosis, laxe pubescentibus, pilis pandentibus 1–1.5 mm. longis: foliolis prope 20 mm. longis, cuneatis, apice rotundatis vel emarginatis pallido-viridis, pilis brevibus albescentibus subter: racemis brevibus, verticillis 2–3, distantibus; floribus parvis, 12–13 mm. longis, pandentibus ad anthesin; pedicellis 1.5–2 mm. longis, gracilibus; bracteis 2–5 mm. longis, inconspicuis: calyce ebracteolato, 7 mm. longo, villoso inferne, pilis prope 1 mm. longis, pandentibus vel retrorso-pandentibus; labio superiore 2 mm. longo, inferiore obtuso, paulo plus 2 mm. lato, 2-dentato, dentibus prope 0.5 mm. longis: corolla alba vel pallida; vexillo 11 mm. longo, 6 mm. lato, apice rotundato paulo abrupte contracto in unguem gracilem 2 mm. latum; alis 10 mm. longis, 4 mm. latis, non ciliatis; carina 10 mm. longa, recta: leguminibus 15 mm. longis, pallido-stramineis; seminibus 4 mm. longis, 3.5 mm.

latis, pinguibus, paulo acute angulatis, dense atro-cinereis maculatis.

Erect, branched about 10 cm. above the base, the branches nearly erect, slender, and somewhat fistulose; leaflets about 20 mm. long, cuneate, the apex rounded or emarginate, pale green, whitened below with conspicuous short subappressed hairs; whorls two or three, flowers small, 12–13 mm. long, spreading in anthesis; calyx only 7 mm. long, the hairs spreading or retrorse-spreading and about 1 mm. long, lower-lip two-toothed; banner 11 mm. long, 6 mm. wide, wings not ciliate, keel straight, all the petals white or pale: pods pale straw-colored; seeds about 4 x 3.5 mm., plump, somewhat acutely angled, densely spotted with dark gray.

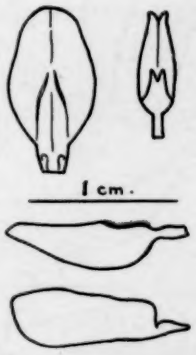

FIG. 27. LUPINUS DENSIFLORUS MCGREGORI C. P. Smith. *Abrams & McGregor 551* (DS 9585).

CALIFORNIA. Los Angeles County: Rock Creek, desert slope of the San Gabriel Mountains, 2–4 July, 1908, *Abrams & McGregor 551* (TYPE, DS 9585; type-duplicates, US, NY, G).

Apparently this form has a number of unique characters. Specimens collected in late May or early June would be interesting. Named for one of the collectors, my friend Ernest Alexander McGregor.

6*k*. **Lupinus densiflorus altus** var. nov. [FIG. 28.]

Ramosus, 30–60 cm. latus, ramis pedunculisque elongatis, caulibus ramisque laxe villosis et pedunculis petiolisque dense villosis, pilis 1 mm. longis: petiolis 10–20 cm. longis; verticillis 6–7, distinctis; floribus 14 mm. longis, pandentibus; calyce ebracteolato, 8 mm. longo, subter dense pandento-pubescenti, labio inferiore recto, paulo inflato, 3 mm. lato, 2-dentato, dentibus 1 mm. longis, sinu dentis vestigio plus minusve instructo: petalis albis; vexillo 13 mm. longo, 7 mm. lato, apice rotundato, paullatim contracto in unguem; alis 12 mm. longis, dense ciliatis ad basin superne; carina curvata: legumina seminaque non vidi.

Branched above the base, 30–40 cm. tall, the branches and peduncles elongated, branches loosely villous, the peduncles and petioles densely villous with hairs 1 mm. long; whorls six or seven,

distinct; flowers spreading, 14 mm. long; calyx ebracteolate, densely pubescent below with spreading hairs, the lower lip straight, but slightly inflated, two-toothed, with or without the interstitial vestigial tooth; petals white, the banner rounded at the apex and gradually contracted into a poorly defined claw, wings densely ciliate at the free edges above, keel evidently curved; pods and seeds not seen.

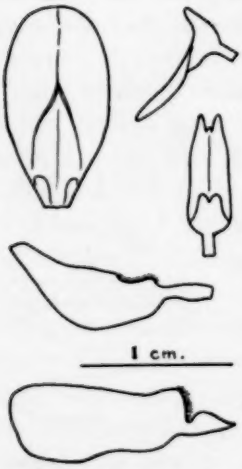

FIG. 28. LUPINUS DENSIFLORUS ALTUS C.P. Smith. *J.B.Davy* 2505(UC 130329).

CALIFORNIA. Los Angeles County: Manzana, Antelope Valley, 9–24 May, 1896, *J. B. Davy 2505* (TYPE, UC 130329).

The collector's label gives generic determination only; but an annotation label calls the specimen an "undescribed sp."

6*l*. **Lupinus densiflorus vastiticola** var. nov. [FIG. 29.]

Acaulescens, eramosus vel ramosus, 9–18 cm. altus: foliolis 10–20 mm. longis, 4–5 mm. latis, oblanceolatis, acutis, laxe villosis superne: pedunculis brevibus, dense villosis, subrufis vel purpureis; verticillis prope 4–5, distantibus; floribus pandentibus, prope13 mm. longis; pedicellis brevibus, robustis; bracteis calyces multo brevioribus: calyce ebracteolato, 8 mm. longo, pilis pandentibus prope 1 mm. longis, labio superiore 2 mm. longo, inferiore paulo inflato ad basin, 3 mm. lato, 2-dentato, dentibus plusculum 0.5 mm. longis, sinu dentis vestigio instructo vel sine eodem; colore corollae incerto; vexillo apice rotundato, paullatim contracto in unguem, 11 mm. longo, 5–6 mm. lato; alis prope 10 mm. longis, 5 mm. latis, ciliatis ad basin superne; carina curvata, maxima 11 mm. longa, 4 mm. lata, acumine brevi latoque: legumina et semina non vidi.

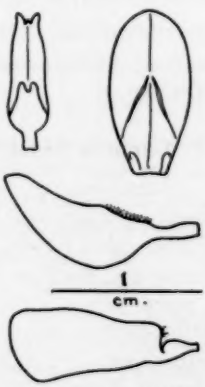

FIG. 29. LUPINUS DENSIFLORUS VASTITICOLA C. P. Smith. *C. G. Pringle* (US 20638).

Simple or branched at the base, 9–18 cm. tall; peduncles short, reddish or purplish, densely villous; whorls about four or five, distant; flowers spread-

ing, about 13 mm. long; calyx ebracteolate, 8 mm. long, its hairs spreading and about 1 mm. long, lower lip somewhat inflated near the base, 3 mm. wide, two-toothed, with or without a vestigial median tooth; color of the corolla uncertain; banner rounded at the apex, gradually contracted into a poorly defined claw; wings ciliate at the base above; keel curved, comparatively large, the point short and wide; fruit and seeds not seed.

Vastiticola is Latin for "waste inhabiting."

CALIFORNIA. "Mojave Desert," 12 May, 1882, *C. G. Pringle* (TYPE, US 20638; type-duplicate, PA).

VERSABILES

6*m*. **Lupinus densiflorus versabilis** var. nov. [FIG. 30.]

Eramosus vel ramosus, 20–40 cm. altus, plus minusve fistulosus cum super basi ramosus, pubescens, pilis brevibus, paulo densis, plurimum retrorso-pandentibus, vix 1 mm. long; petiolis laxe pubescentibus vel sublevibus, 6–18 mm. longis; foliolis 6–10, 20–35 mm. longis, subrectis vel arcuatis, oblanceolatis, acutis, subter specie levibus, quamquam minute appresso-pubescentibus, medio-costis marginibusque ciliatis; pedunculis paulo brevibus vel elongatis, verticillis 4–10 appositis vel distantibus; floribus ad anthesin et postea pandentibus, 14–16 mm. longis; pedicellis prope 2 mm. longis, paulo gracilibus; bracteis verticilli humillimi vix 10 mm. longis, marginibus ciliatis; calyce frequenter bracteolato, 9–10 mm. longo, aliquantum dense pubescente, pilis brevibus laxe appressis, 0.5 mm. longis, labio superiore diverso, 2–3 mm. longo, inferiore inflato 2–3 mm. lato, 2-dentato, dentibus 0.5–1 mm. longis; corolla alba, diverse roseo- vel violaceo-tincta; vexillo apice rotundato, 14–16 mm. longo, 7–8 mm. lato, paulatim contracto ungue rigido, 4–5 mm. lato; alis 12–14 mm. longis, prope 6

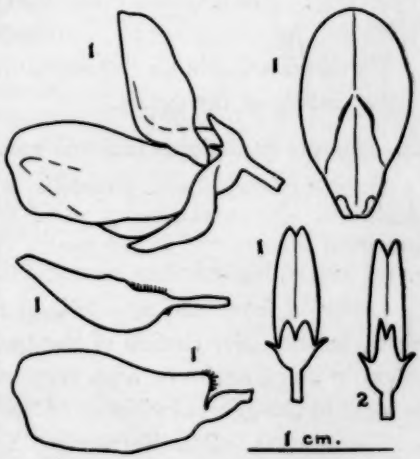

FIG. 30. LUPINUS DENSIFLORUS VERSABILIS C. P. Smith. 1. *A. A. Heller 8174* (DS 9593); 2. *A. A. Heller 7638* (CPS).

mm. latis, ad basin subter manifeste ciliatis; carina subrecta, vel paulo curvata 11–12 mm. longa.

This variety of the San Joaquin Valley and adjacent foothills of the Sierras differs from var. *Dudleyi* in the shorter pubescence of the calyx, the usually more richly tinted corollas, and the decided prevalence of interstitial bracteoles. While seeds of var. *Dudleyi* have not yet been seen by me, I have no doubt but that such will be found to differ considerably from those of var. *versabilis*. Seeds with the San Joaquin County plant, cited below, are milky-white, unmarked, rather smooth and plump, about 5 x 4 mm.

CALIFORNIA. Fresno County: Fresno, 13 Apr., 1906, *A. A. Heller 8174* (TYPE, DS 9593; type-duplicate, US). Kern County: near Bakersfield, 10 Apr., 1905, *A. A. Heller 7638* (DS, US, CPS). Madera County: Madera, 22 Apr., 1897, *W. A. Setchell* (UC); North Fork and vicinity, 30 May–8 June, 1903, *D. Griffith 4622* (US). Amador County: Jackson Gate, May, 1892, *G. Hansen 1314* (DS, UC); Stony Creek, 26 May, 1896, *G. Hansen 1674* (US). San Joaquin County: Tracy, 10 Apr., 1900, *B. Cobb* (UC).

Versabilis is Latin for "changeable" and refers to the variation in the tinting of the petals.

6n. **Lupinus densiflorus latidens** var. nov. [FIG. 31.]

Habitu notisque var. *versabilis*, a ipso differt pilis pandentibus plurimum laxe vix 0.3–0.5 mm. longis; labio calycis inferiore interdum integro vel 2–3-dentato, dentibus plurimum latioribus quam longis; leguminibus secundis prope 15 mm. longis.

Differing from var. *versabilis* in the somewhat shorter pubescence, in the paler tinting of the petals, as a rule, and the lower calyx-lip being entire or with very wide short teeth. It seems to be local in the general vicinity of San Bernardino.

CALIFORNIA. San Bernardino County: vicinity of San Bernardino, 20 May, 1896, *S. B. Parish 4165* (TYPE, US 279032; type-duplicates, NY, G, UC); Redlands, May, 1890, *S. B. Parish* (US); vicinity of San Bernardino, 11 May, 1901, *S. B. Parish 4783* (DS). Riverside County: Temicula, 1880, *G. R. Vasey 96* (US). County not given: *J. M. Biglow* (Whipple's Exploration of the 35th Parallel), 1853 (US); foothills, May, 1887, *S. B. Parish* (UC).

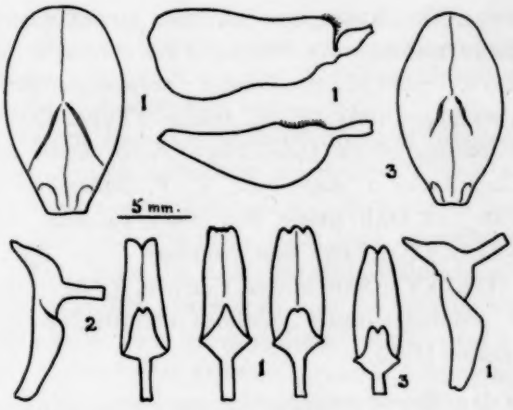

FIG. 31. LUPINUS DENSIFLORUS LATIDENS C. P. Smith. 1. *S. B. Parish 4165* (US 279032); 2. *J. M. Bigelow* (US 20644); 3. *S. B. Parish* (US 480801).

60. **Lupinus densiflorus Dudleyi** var. nov. [FIG. 32.]

Ramosus, prope basin manifeste pubescens, pilis retrorso-pandentibus prope 0.5 mm. longis; racemis pluribus, verticillis 5–10 vel pluribus, plus minusve appositis; floribus 15–16 mm. longis; bracteis humilioribus, calyces excedentibus longitudine; calyce interdum bracteolato, plerumque ebracteolato, 10 mm. longo, subter laxe villoso, pilis pandentibus, 0.5–1.5 mm. longis, labio superiore 2.5–3 mm. longo, inferiore plerumque inflato prope 3 mm. lato, bidentato, sinu dentis vestigio instructo, dentibus 0.75–1.5 mm. longis; petalis albis vel pallido-roseis; vexillo apice rotundato, 14 mm. longo, prope 8 mm. lato, paulo abrupte contracto ungue 4 mm. lato; alis 12–13 mm. longis, apice prope 7 mm. latis, ad basin superne ciliatis; carina 10–11 mm. longa, acumine subvexo; leguminibus secundis, 15 mm. longis: semina non vidi.

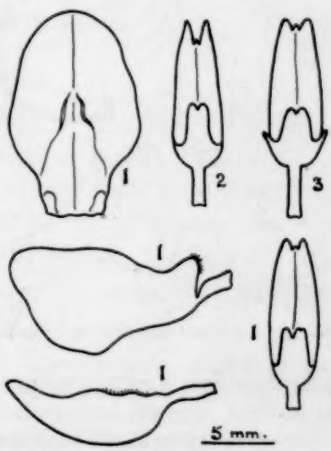

FIG. 32. LUPINUS DENSIFLORUS DUDLEYI C. P. Smith. 1. *C. P. Smith 1442*; *C. F. Baker 850* (US 440513); 3. *A. D. E. Elmer 4847* (US 665734).

The rounded banner and the short retrorsely spreading pubescence distinguish this quite local variety of the San Francisco

peninsula, etc. The flowers are white or tinted with rose-pink, commonly large and showy. The pods are conspicuously secund.

CALIFORNIA. San Mateo County: serpentine rock west of San Mateo, 26 Mar., 1894, *W. R. Dudley* (TYPE, DS); Pilarcitos Lake and Canyon, 21–23 June, 1893, *J. B. Davy 1151* (UC); Crystal Springs Lake, 1 May, 1902, *C. F. Baker 850* (US); near San Mateo on the Half Moon Bay road, 23 May, 1907, *A. A. Heller 8561* (DS, US); Lake San Andreas, June, 1903, *A. D. E. Elmer 4847* (US, NY); San Mateo Canyon, 31 May, 1908, *C. P. Smith 1442*. Marin County: without definite locality, 4 June, 1895, *I. Tidestrom* (UC).

6*p*. **Lupinus densiflorus persecundus** var. nov. [FIG. 33.]

Humilis, 5–15 cm. altus, ramis brevis subpandentibus, pedunculis eorum plerumque plus pandentibus; foliis congestis, viridis, peculiaribus; petiolis 3–8 cm. longis, pilis 1 mm. longis, laxe panden-

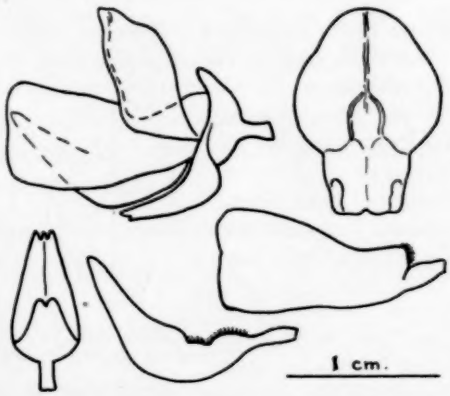

FIG. 33. LUPINUS DENSIFLORUS PERSECUNDUS C. P. Smith. *M. E. Jones 3329* (US).

tibus; foliolis 6–8, prope 20 mm. longis, 4–6 mm. latis, acutis, superne sublevibus, inferne laxe pubescentibus: pedunculis foliis aequantibus vel ea excedentibus, laxe pubescentibus, racemis aliquantum deflexis; verticillis 1–4, distinctissimis, floribus manifeste secundis, prope 16 mm. longis; pedicellis 1.5–2 mm. longis; calyce ebracteolato, 9 mm. longo, 4–5 mm. lato, laxe pandentibus pubescente, pilis vix 1 mm. longis, labio superiore 3 mm. longo, emarginato, inferiore 3-dentato, dento medio lateralibus minore interdum vestigio; petalis atro-purpureis, praesertim ad dimidia externa; vexillo 12 mm. longo, 10 mm. lato, apice rotundato, abrupte con-

tracto ungue inflato 6 mm. lato superne, 4 mm. lato basi; alis 13 mm. longis, ciliatis ad basin superne; carina 12 mm. longa, curvatissima, acumine longissimo gracile; fructibus manifeste secundis, specie usitatibus: semina non vidi.

Low, 5–15 cm. high, the branches more or less spreading with usually more widely spreading peduncles; whorls one to four, remote, the flowers secund and largely dark purple in color, about 16 mm. long; calyx ebracteolate, 9 mm. long, its pubescence spreading, about 1 mm. long, the lower lip mainly three-toothed; banner 12 x 10 mm., abruptly contracted into an inflated claw which is 6 mm. wide above; keel 12 mm. long, much curved and with a long slender apex; fruits strongly secund, otherwise apparently not distinctive; seed not seen.

CALIFORNIA. Sonoma County: Duncans Mills, 17 July, 1882, *M. E. Jones 3329* (TYPE, US; type-duplicates, NY, Utah Agr. Col.); cliffs near Bodega Bay, 30 June, 1907, *K. Brandegee* (UC). Marin County: Dillons, Dec., 1898, *R. E. Gibbs* (UC).

Persecundus is used in the sense of "strongly secund" and refers to the position of the flowers and fruits on the rachis. The type collection is labelled *L. microcarpus*.

PALUSTRES

6*q*. **Lupinus densiflorus palustris** (Kell.) comb. nov. [FIG. 34.]

Lupinus densiflorus Agardh, Syn. Gen. Lup. 1835.

Lupinus palustris Kell. Proc. Cal. Acad. Sci. **5**: 16. 1873.

Agardh's description, in part, will be found on page 169, with the general discussion of *L. densiflorus* Benth.

Kellogg's description of *L. palustris*, somewhat abridged, follows:

> Stem stout, annual, fistulose . . . often . . . branching . . . beyond the main axis and its elongated terminal spike; long, soft, silky, pubescent, or subglabrous, with barely very minute villi . . . leaflets . . . glabrous above, subpubescent beneath . . . spike 6 to 12 inches; flowers large, violet-blue, pinkish or verging to white, pedicellate, subverticellate or verticellate . . . subscarious calyx bracteolate or ebracteolate hirsute . . . slightly saccate; upper lip 2-toothed, lower herbaceous lip mostly 2-toothed, seldom sub-entire; wings very broad, obtuse, with a rhomboidal outline; petals equal. Legumes very appressed, (silvery?) hirsute, compressed, an inch or more in length, about 8-seeded.
>
> Collected by Kellogg and Bloomer on the San Joaquin River, April 7th, 1869. Differs from *Menziesii*—a 2-seeded species,—whereas this has 8 or more; also one var. (deep purple-blue flower) has very distinct bracteoles.

This description has been a puzzle to me since I first studied it in 1910, and no solution to the matter suggested itself until recently, when it was my pleasure to examine, at the Gray Herbarium, one of Kellogg's specimens distributed by himself as his *L. palustris*, and collected in April, 1869. This is in flower only, but it is the same as *L. densiflorus* Agardh, and agrees with Kellogg's description, as far as same applies at all to a *Platycarpos* species. It may be that Kellogg's type-collection included some very peculiar pathological specimens; but I am more inclined to believe that he actually confused flowering specimens of this variety of *L. densiflorus* with fruiting specimens of a quite different species, perhaps the robust annual now known as *L. affinis* Agardh.

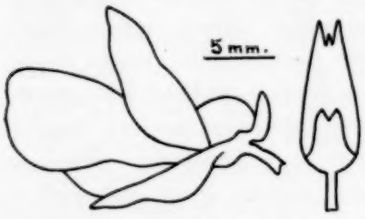

FIG. 34. LUPINUS DENSIFLORUS PALUSTRIS (Kell.) C. P. Smith. *A. Kellogg*, Apr., 1869 (G), not dissected.

However, as attested by Bentham himself, Agardh's *L. densiflorus* can not be accepted as the typical form of the species, and it seems to me that this easily recognizable form, as a variety, should bear Kellogg's name.

Another specimen in the Gray Herbarium calls for special attention, said specimen being the one labelled "*L. Menziesii*, var. *aurea*, Kellogg and Brannan. Jr., San Joaquin River, 22 April 1870." As may be seen by referring to the original description (see page 177), Kellogg's type is said to have been taken at "Deer Valley, near Antioch, San Joaquin River, April 22, 1869." One might easily assume that the discrepancy in date, 1869 *vs.* 1870, is a mere clerical error, overlooked by the person who wrote out the label in question. The specimen, however, according to the descriptions, is not Kellogg's var. *aurea*, but is the same as his *L. palustris*. As to the locality, Antioch and vicinity, my citations will show that Davy also collected var. *palustris* at Antioch in 1895, and that Miss Eastwood and Mrs. Brandegee each collected *L. Menziesii* (probably var. *aurea*) at Antioch in 1893 and 1907, respectively. Still a third variety of *L. densiflorus* and also the typical *L. subvexus* have been taken at Antioch. I accordingly

wonder if this particular specimen was not labelled on the basis of the collectors and part of the date (22 April), rather than with careful regard to the description of var. *aurea*.

Var. *palustris* shares with typical *L. subvexus* a pronounced tendency toward a covering of long loose hairs, those of the calyx, especially, being 2–4 mm. long. The "*palustris* varieties" of *L. densiflorus*, however, may be distinguished from the varieties of *L. subvexus* by the position of the flowers soon after anthesis, the flowers soon turning up in *L. subvexus*, without becoming secund, as is so frequent in many varieties of *L. densiflorus* as the fruits develop. Some of the extreme "*palustris* variations" are below designated as separate varieties, most of which have commonly been labelled as *L. microcarpus*. One of these, however, has been named, but not described, by Miss Eastwood.

To supplement Kellogg's and Agardh's descriptions, I would mention the following diagnostic points:

Flowers spreading in anthesis and later; calyx usually ebracteolate, 12–13 mm. long, bushy-villous below, especially on the cup, the hairs 2–4 mm. long, upper lip various but usually large, about 3 mm. long, lower lip inflated near base, 3–4 mm. wide, two-toothed, with or without an interstitial vestige; petals white or tinted with pink or purple; banner rounded apically, 15–17 mm. long, 8 mm. wide, rather abruptly contracted at base, the basal inflation more or less saccate, pressing the upper lip backward; wings 13–15 mm. long, sometimes ciliate at the free edges above; keel 11–13 mm. long, slightly to considerably arcuate; pods 14–16 mm. long; seeds probably dull yellow, sparsely speckled with dark brown, about 5 x 4 mm. (DS 9588).

CALIFORNIA. County not given: San Joaquin River, Apr., 1869, *A. Kellogg* (G); San Joaquin River, 22 Apr., 1870, *A. Kellogg & S. Brannan, Jr.* (G); no data (DS 9588). Contra Costa County: Antioch, Apr., 1895, *J. B. Davy* (UC). Alameda County: vicinity of Berkeley, May–June, 1906, *H. A. Walker 173* (UC); Berkeley, June, 1894, *W. S. Blasdale* (US). Santa Cruz County: Watsonville coast, 13 Apr., 1902, *C. F. Baker 3009* (US, NY, G). Monterey County: Monterey, *T. Hartweg 1692* (G); Monterey, *J. G. Cooper* (US); dry ravine, Monterey, May, 1850, *C. C. Parry* (T).

6*r*. **Lupinus densiflorus stanfordianus** var. nov. [FIG. 35.]

A var. *palustri* differt labio inferiore calycis 3-dentato, dente medio plerumque amplo; corolla pallido-luteolo-alba vel pallido-rosea; vexillo apice acuto vel abrupte contracto ungue rigido; seminibus 4 x 5 mm., asperibus, atro-fulvis maculis non claris.

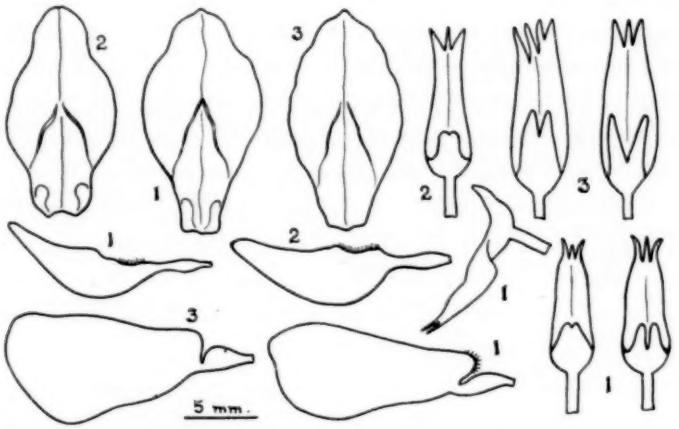

FIG. 35. LUPINUS DENSIFLORUS STANFORDIANUS C. P. Smith. 1. *C. P. Smith 791*; 2. *A. D. E. Elmer 2190* (US 655041); 3. *W. F. Wight 140* (US 467702).

Lower lip of the calyx three-toothed, the median tooth being well-developed; petals creamy or rose-tinted, the banner acute or abruptly contracted at the apex, the claw stiff; seeds rough, dark brown with indistinct specks; leaflets conspicuously ciliate on the midribs and margins.

CALIFORNIA. Santa Clara County: Stanford University, base of foothills, 9 Apr., 1905, *C. P. Smith 791* (TYPE, CPS); 16 Mar., 1900, *W. F. Wight 140* (US); Stanford University, Apr., 1900, *W. A. Atkinson* (DS); west of road near Rocy House, 6 Mar., 1900, *W. A. Atkinson* (DS); near Stanford University Apr., 1900, *A. D. E. Elmer 2190* (US); foothills, Stanford University, 8 Apr.–4 May, 1902, *C. F. Baker 475* (US, DS, NY, G). San Mateo County: Stanford University, by road from county bridge to Basaltic Rocks, 10 May, 1897, *W. R. Dudley* (DS); Los Trancos road, near Stanford University, 1 Apr., 1905, *C. P. Smith 727* (CPS); Stockfarm bridge, near Stanford University, 13 Apr., 1908, *C. P. Smith 1401* (CPS).

6*s*. **Lupinus densiflorus crinitus** Eastwood, var. nov. [FIG. 36.]

Humilis, 8–15 cm. latus, villosissimus, pilis 3–5 mm. longis, caule ramisque brevibus plerimum laxe pandentibus; foliis congestis; pedunculis plus minusve decumbentibus vel deflexis, folia excedentibus praesertim ad fructum; verticillis 2–4 distantibus, floribus prope 14 mm. longis, pedicellis brevibus robustis; calyce ebracteolato, 10 mm. longo, 4 mm. lato, dense villosissimo, pilis 2–3 mm. longis, labio superiore 3 mm. longo, emarginato, inferiore 2-dentato, dentibus 1 mm. longis et 1 mm. latis basi, sinu lato; corolla plurimum atro-purpurea, vexillo 13 mm. longo, 8 mm. lato, apice rotundato abrupte contracto in unguem prope 4 mm. latum; alis 11 mm. longis, 6 mm. latis, basi ciliatis; carina 10 mm. longa, subrecta; leguminibus magnis, 15–18 mm. longis; seminibus angulatis, luteofulvis, dense minuteque maculatis maculis fulvis.

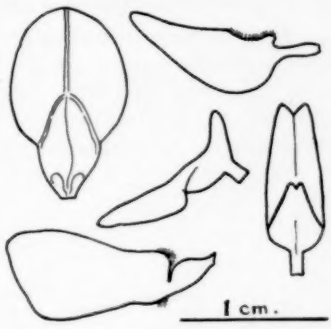

FIG. 36. LUNPIUS DENSIFLORUS CRINITUS Eastwood. *A. Eastwood* (G).

Low, 8–15 cm. tall, very villous with hairs 3–5 mm. long, stem and branches short and usually loosely spreading with the peduncles more or less decumbent or deflexed, exceeding the foliage at time of fruiting; verticils two to four, distinct, flowers about 14 mm. long; calyx ebracteolate, 10 mm. long, very densely villous with hairs 2–3 mm. long; corolla mostly dark purple, the banner 13 mm. long, rounded at the apex and abruptly contracted into a wide claw, wings ciliate, keel nearly straight; pods large; seeds angular, yellowish brown, densely and minutely spotted with brown.

CALIFORNIA. Sonoma County: Bodega Point, *A. Eastwood* (TYPE, G; type-duplicate, UC); Bodega, 25 May, 1900, *H. P. Chandler 686* (UC).

The type sheet is labelled "*Lupinus crinitus* n. sp.," but an annotation, in pencil, calls it *L. densiflorus*, var. *crinitus*. It seems to be a local and well-marked variation of the "*palustris* group" and peculiar to the coast line; while var. *persecundus* (page 190), of similar general appearance, but very different pubescence, is evidently nearer typical *L. densiflorus* and is found both near the

coast and also up in the mountains of the same local region. This region is not readily accessible to botanists; but I surmise that it would prove to be an especially interesting locality to taxonomists of ecological bent.

6*t*. **Lupinus densiflorus curvicarinus** var. nov. [FIG. 37.]

Eramosus vel super basi ramosus, 25–30 cm. altus, laxe villosus; foliolis subter specie levibus sed vero pubescentibus, pilis laxe appressis brevibus, medio-costis marginibusque ciliatis; verticillis 2–17, plurimum distantibus, floribus laxe pandentibus, 13–14 mm. longis, pedicellis 2 mm. longis, gracilibus, bracteis verticillorum humiliorum 15 mm. longis; calyce 8 mm. longo, subter laxe villoso, pilis 1.5–2 mm. longis, labio superiore emarginato, prope 2 mm. longo, inferiore lanceolato-ovato, inflato, bidentato, dentibus sinuque, gracilibus, 1 mm. longis; corolla pallido-rosea vel purpurea, vexillo 12 mm. longo, 7 mm. lato, apice rotundato, alis 11 mm. longis, carina curvatissima ad basin ciliata; leguminibus pallido-stramineis, 12 x 8–13 x 9 mm.; seminibus asperibus, atro-fulvis, maculis non claris.

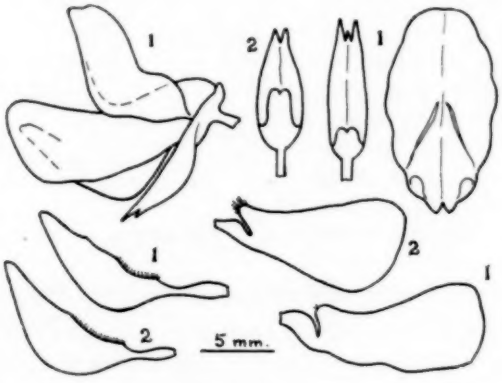

FIG. 37. LUPINUS DENSIFLORUS CURVICARINUS C. P. Smith. 1. *K. Brandegee* (UC 155195); 2. *C. P. Smith 1460*.

Loosely villous, 25–30 cm. tall, branched above the base or simple; leaflets apparently glabrous below, but in reality pubescent with loosely appressed short hairs, the margins and midribs often ciliate; flowers loosely spreading, 13–14 mm. long; calyx 8 mm. long, loosely villous below with hairs 1.5–2 mm. long, upper lip emarginate, about 2 mm. long, lower lip lance-ovate, evidently

bent and subsaccate, the two teeth and the sinus slender; petals pale rose or purple, banner 12 mm. long, 7 mm. wide, rounded at the apex, keel decidedly curved, ciliate; seeds rough, dark brown, the markings indistinct.

CALIFORNIA. Yolo County: Woodland, 20 May, 1893, *J. W. Blankinship* (TYPE, G). Contra Costa County: Antioch, 5 May, 1907, *K. Brandegee* (UC 155195, except as to the specimen of var. *Menziesii* in center of sheet). Alameda County: Livermore, 16–17 May, 1891, *W. L. Jepson* (UC). Santa Clara County: Stanford University, 5 May, 1895, *C. Rutter 173* (US 308269, specimen on left only); Stanford University, 8 June, 1908, *C. P. Smith 1460* (CPS).

Curvicarinus is Latin for "curved keel."

6*u*. **Lupinus densiflorus Reedii** var. nov. [FIG. 38.]

Eramosus, humilis, 4–10 cm. altus, villosus; petiolis 1–4 cm. longis, foliolis 1–2 cm. longis, villosis; pedunculis folia excedentibus, verticillis 2–6, distantibus, floribus pandentibus, prope 13 mm. longis, pedicellis gracilibus, prope 2 mm. longis; calyce ebracteolato, 8 mm. longo, pilis densis, prope 1.5 mm. longis, labio superiore emarginato, vix 2 mm. longo, inferiore manifeste inflato, 2 mm. lato 3-dentato, dentibus 1 mm. longis, medio graciliore; colore corollae non claro, vexillo 12 mm. longo, 7 mm. lato, apice rotundato, carina 9 mm. longa, comparate brevi; legumina seminaque non vidi.

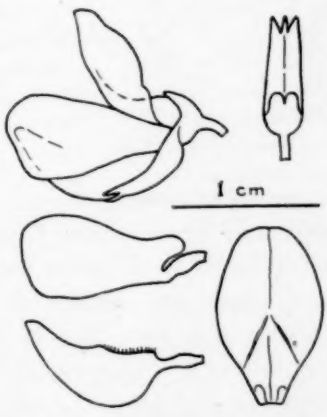

FIG. 38. LUPINUS DENSIFLORUS REEDII C. P. Smith. *E. C. Reed*, Concepcion (G).

Simple and low, 4–10 cm. tall, villous; verticils two to six, distant, flowers spreading, about 13 mm. long; calyx ebracteolate, 8 mm. long, upper lip emarginate, lower lip manifestly bent and inflated near base, three-toothed, the median tooth more slender; color of corolla not evident, banner 12 mm. long, 7 mm. wide, rounded at the apex, keel comparatively short, 9 mm. long; pods and seeds not seen.

CHILE: Concepcion, *E. C. Reed* (TYPE, G).

The sheet bears two plants. The flowers are well pressed, but the color of the petals is not preserved. *L. microcarpus* is the determination given, to which Miss Eastwood has added, "not typical."

6*v*. **Lupinus densiflorus trichocalyx** var. nov. [FIG. 39.]

Eramosus vel basi ramosus, 20–30 cm. altus, dense villosus; petiolis 10–14 cm. longis, foliolis maximis, 30 mm. longis, subter manifeste villosis; pedunculis prope folia aequantibus, verticillis prope 7, distantibus, floribus ad anthesin et specie postea pandentibus, 12 mm. longis, pedicellis prope 1 mm. longis, robustis, bracteis brevibus; calyce ebracteolato, 8 mm. longo, subter dense villoso pilis 2 mm. longis, labio superiore bipartito, inferiore lanceolato, bidentato, dentibus 1 mm. longis, parallelis, gracilibus; colore corollae non claro, specie purpureo, vexillo 12 mm. longo, 6 mm. lato, apice rotundato ungue lato, alis 10 mm. longis ad basin superne ciliatis, carina 9 mm. longa, curvata: legumina seminaque non vidi.

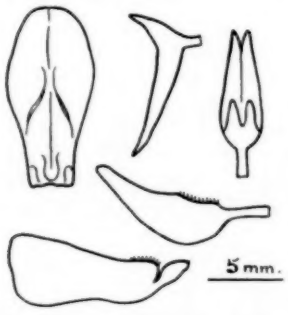

FIG. 39. LUPINUS DENSIFLORUS TRICHOCALYX C. P. Smith. *D. Douglas* (G).

Densely villous, 20–30 cm. tall, simple or branched at the base; verticils about seven, remote, flowers spreading in anthesis and seemingly later, 12 mm. long, pedicels short and stout and bracts short; calyx ebracteolate, bushy villous below with hairs 2 mm. long, upper lip two-parted, lower lip lanceolate, the two teeth about 1 mm. long, slender and parallel; color of the corolla not certain but probably purplish, banner 12 x 6 mm., rounded at the apex and with a broad claw, wings ciliate at the free edges above, keel curved: pods and seeds not seen.

CALIFORNIA. County not given: 1829, *D. Douglas*, ex. Herb. Lindley (TYPE, G); Saucelito, 21 May, 1874, *J. G. Lemmon 46* (G).

Perhaps related to this, but not at all typical, are the following: near Tulare Lake, July, 1878, *J. G. Lemmon 124* (G); Cuyama River, 27 May, 1896, *A. Eastwood* (G); Arroyo Grande, May, 1895, *M. Alice King* (UC).

The Douglasian plant upon which this variety is primarily based is probably one of the collection referred by Agardh to *L. microcarpus*,—in his words, "Etiam e California retulit Douglas." An annotation on the type sheet states that this is the *L. microcarpus* of Torrey & Gray's Flora of North America. If, as is very probable, the "Saucelito" of Lemmon is the same as the town now called Sausalito, in Marin County, such might have been the locality of Douglas's collection of "*L. microcarpus*." It seems to me more probable, however, that these plants came from Santa Barbara or San Luis Obispo County.

6*w*. **Lupinus densiflorus barbatissimus** var. nov. [FIG. 40.]

Ramosus, prope 10 cm. super basi, 25–35 cm. altus, villosus, ad basin fistulosus; petiolis longissimis, 12 cm. longis, foliolis 20–30 mm. longis, superne laxe villosis; verticillis prope 10 appositis, floribus prope 12 mm. longis, pandentibus, pedicellis prope 2 mm. longis, paulo gracilibus, bracteis villosissimis; calyce ebracteolato, 8 mm. longo, subter villosissimo, pilis 2 mm. vel plus longis, labiosuperiore prope 1 mm. longo, emarginato, inferiore manifeste inflato, 2 mm. lato, 3-dentato, dentibus 1 mm. longis, medio gracillimo; colore corollae non claro, specie roseo vel purpureo, vexillo11 mm. longo, 5 mm. lato, apice acuto, paullatim contracto in unguem non clarum, carina prope 8–9 mm. longa, acumine brevissimo: legumina seminaque non vidi.

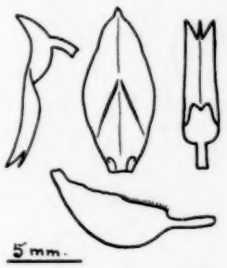

FIG. 40. LUPINUS DENSIFLORUS BARBATISSIMUS C. P. Smith. *James Macrae* (G).

Branched above the base, 25–35 cm. tall, fistulose at the base, villous; whorls about ten, approximate, flowers spreading, about 12 mm. long, bracts very villous; calyx ebracteolate, strongly bearded below with hairs 2 mm. or more long, upper lip emarginate, about 1 mm. long, lower lip manifestly subsaccate, tridentate, the median tooth slender; corolla apparently rose or purple, banner 11 x 5 mm., acute at the apex, slightly contracted into an indistinct claw, keel about 8–9 mm. long, with a short apical point: pods and seeds not seen.

CHILE. Bath of Collina, Andes, *James Macrae* (TYPE, G).

The sheet bears the following annotations:

L. microcarpus ? *β barbatus* Gray in Hb. Kew.

Part fr. Hb. Hook. The plant which Agardh, from Hb. Lindl., under *L. microcarpus*, refers to as 'huic proximum,' and identifies with Dougl. Calif.

Thus it is evident that neither Agardh nor Gray considered this plant to be typical *L. microcarpus*. The name "*barbatus*" is not now available, as it has been applied by Henderson to an Oregon lupine of the *Polyphylli*.

Barbatissimus, "very much bearded," refers to the very shaggy calyx, etc.

6*x*. **Lupinus densiflorus austrocollium** var. nov. [FIG. 41.]

A var. *palustri* differt labio inferiore calycis subrecto vix inflato; floribus 13 mm. longis, vexillo plurimum apice acuto, 11–13 mm. longo, 6–7 mm. lato, alis 11 mm. longis, ad basin ciliatis; leguminibus 13–16 mm. longis: semina matura non vidi.

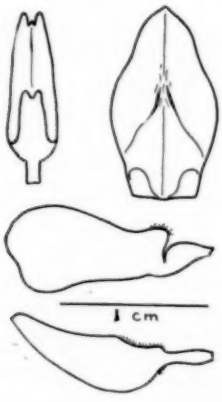

FIG. 41. LUPINUS DENSIFLORUS AUSTROCOLLIUM C. P. Smith. *L. R. Abrams 3465* (US 614007).

Differs from var. *palustris* in the lower lip of the calyx being nearly straight and hardly inflated; flowers 13 mm. long, banner usually acute at the apex, 11–13 x 6–7 mm. long, wings 11 mm. long; pods 13–16 mm. long; matured seed not seen.

CALIFORNIA. San Diego County: near St. Mary's hospital, San Diego, 12 May, 1903, *L. R. Abrams 3465* (TYPE, DS9 579; type-duplicates, US, PA, NY, G); San Diego, May, 1852, *G. Thurber 579* (NY,G); San Diego, 22 Apr., 1885, *C. R. Orcutt* (Col U); San Diego, 1876, *W. G. W. Harford 185* (NY); Harbison Canyon, Sweetwater Valley, 6 May, 1888, *G. C. Deane* (G); San Ysabel, 12 May, 1893, *H. W. Henshaw 21* (US); El Cajon, 8 Apr., 1894, *T. S. Brandegee* (UC); San Diego hills, June–July, 1895, *S. G. Stokes* (DS); Canyon Road, San Diego Park, May,1905, *K. Brandegee* (UC); San Diego, May, 1906, *Brandegee* (NY).

Apparently confined to the foothills about San Diego. It is probable that all the specimens listed above should not be included under one and the same name. Considerable variation exists and it is possible that none of them should be included in

the *L. densiflorus* series. Some are labelled "*L. densiflorus*," others "*L. microcarpus*." Careful field work is needed here.

Austrocollium, "of the southern foothills," is from the genitive plural of *collis*, "foothill," and *australis*, "southern."

6*y*. **Lupinus densiflorus scopulorum** var. nov. [FIG. 42.]

Ad basin ramosus et superne subramosus, caule 20–30 cm. alto, villoso, pilis 2–3 mm. longis; petiolis 4–8 cm. longis, conspicue villosis, foliolis 15–25 mm. longis, oblanceolatis, apice rotundatis vel angulatis, subter laxe villosis; pedunculis folia excedentibus vel brevioribus, verticillis 3–5, appositis, floribus ad anthesin et postea pandentibus, prope 15 mm. longis, pedicellis 2½ mm. longis, gracilibus,

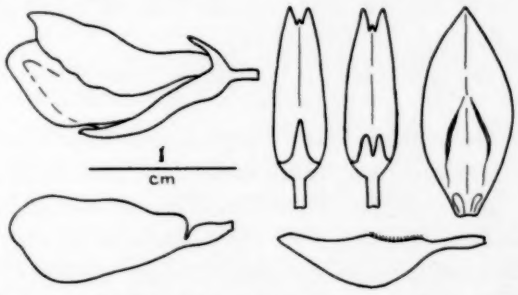

FIG. 42. LUPINUS DENSIFLORUS SCOPULORUM C. P. Smith. *J. Macoun* (US 20837).

bracteis villosissimis, cito reflectentibus marescentibusque; calyce ebracteolato, prope 11 mm. longo, labio superiore 2–3 mm. longo, diverso, interdum integro, inferiore villosissimo ad anthesin recto ad fructum subinflato, 3–4 mm. lato, 2-dentato, sinu lato dentis vestigio instructo; petalis pallido-luteolo-albis, vexillo 14 mm. longo, 6 mm. lato, medio maculato paullatim contracto, apice acuto et ungue gracili non claroque, alis 12 mm. longis, 6 mm. latis, non ciliatis, carina 10 mm. longa, subrecta; leguminibus prope 14 x 10 mm.: semina matura non vidi.

Branched at the base and subbranched above, 20–30 cm. tall, villous with hairs 2–3 mm. long; verticils three to five, approximate; flowers spreading in anthesis and later, about 15 mm. long; bracts soon reflecting and withering; calyx without bracteoles, about 11 mm. long, upper lip 2–3 mm. long, entire or variously toothed, lower lip very villous, straight in anthesis, slightly inflated in fruit, two-toothed, the sinus wide with a vestigial tooth present; petals pale yellowish white, banner 14 x 6 mm., gradually con-

tracted into an acute apex and an ill-defined slender claw, wings 12 x 6 mm., non-ciliate, keel nearly straight: mature seed not seen.

BRITISH COLUMBIA. Vancouver Island: sea cliffs, Beacon Hill, 4 July, 1889, *J. Macoun 21* (TYPE, US 20837; type-duplicates, T, G); Aug., 1873, *H. Edwards* (NY); cliffs by sea, Beacon Hill Park, Victoria, *A. J. Pineo* (UC).

WASHINGTON. Island County: Whidby Island, *N. L. Gardner* (UC).

While this form and the var. *austrocollium* may not be properly included in *L. densiflorus*, they certainly are less closely related to typical *L. microcarpus;* and var. *scopulorum* is certainly specifically distinct from its nearest neighbor, the Yakima Valley form I have called var. *fluviatilis* of *L. subvexus*.

Scopulorum, "of the cliffs," is the genitive plural of *scopulus*.

More extended and much more careful field study of these forms should contribute both taxonomic and ecological data. Interesting genetical data should also be obtainable from garden cultures; but one would have to devise first a suitable method of treating the seed in order to obtain proper germination, for the "hard-seed problem" would probably be the first stumbling stone to success in cultural studies—at least that has been my experience.

The collection and identification of seeds should be pursued with especial care, as one may often carelessly, though unintentionally, mix in collecting, at one time and locality, seed of more than one species or variety.

To the many friends who have generously assisted me in many different ways my full appreciation is herewith acknowledged. Listing of all of them will not be attempted here; but I cannot refrain from mentioning Drs. B. L. Robinson, H. M. Hall, and P. A. Rydberg, Professors H. H. Bartlett and L. R. Abrams, and Mr. Sidney F. Blake. Mr. Blake, while in England, looked up the old material of *L. microcarpus*, *L. densiflorus*, etc., and gave me certain valuable information.

COLLEGE PARK,
MARYLAND

Studies on the vegetation of New York State—II. The vegetation of a glacial plunge basin and its relation to temperature *

LOREN C. PETRY

(WITH THREE TEXT FIGURES)

A striking feature of the topography of the region immediately about Syracuse, New York, is the occurrence of numerous plunge basins produced by waterfalls during the later stages of the glacial period. The recently established Clarke State Reservation near Jamesville contains several of these basins; Green Lake in the Reservation occupies the bottom of a large typical one. Some of these are known to botanists acquainted with this region as the habitat of certain rare ferns, especially *Botrychium Lunaria* (L.) Sw. (*B. onondagense* Underwood) and *Scolopendrium vulgare* Sm. Maxon† and others have noted that these stations for *Scolopendrium* are always quite cool in summer. Some of these plunge basins show such remarkably low summer temperatures and display a vegetation so distinctly northern in character that a preliminary study of one of them was made during the summers of 1916 and 1917.

The basin studied lies near White Lake, six miles southeast of Syracuse. It is a natural amphitheater, elliptical in shape, with sloping sides; at the top or rim it measures about six hundred feet in length and four hundred fifty feet in width, and has a maximum depth of about ninety-five feet. Along part of the rim there are cliffs five to fifteen feet in height, and the slope begins at their foot; elsewhere the slope begins at the rim and descends at an angle of approximately thirty degrees until the opposite slope is met. The longer axis of the basin lies on an east-west line, and

* The first of this series is a general discussion of the outstanding features of the vegetation of New York state as a whole; the citation to this is as follows:

Bray, W. L. The development of the vegetation of New York State. N. Y. State Coll. Forestry, Syracuse, N. Y. Tech. Pub. 3, 1915.

† Maxon, W. R. On the occurrence of the Hart's Tongue in America. Fernwort Papers 30–46, Dec. 1900.

the bottom presents the appearance of a ravine running in that direction. The outlet of the basin lies to the southeast, where there is a notch about fifty-five feet in depth in the rim; this lowest point of the rim is forty feet above the bottom of the basin, which lies at an altitude of about six hundred ten feet above sea level.

The basin lies in rather thick-bedded limestone for its entire depth, and the slopes are formed of debris of this material.

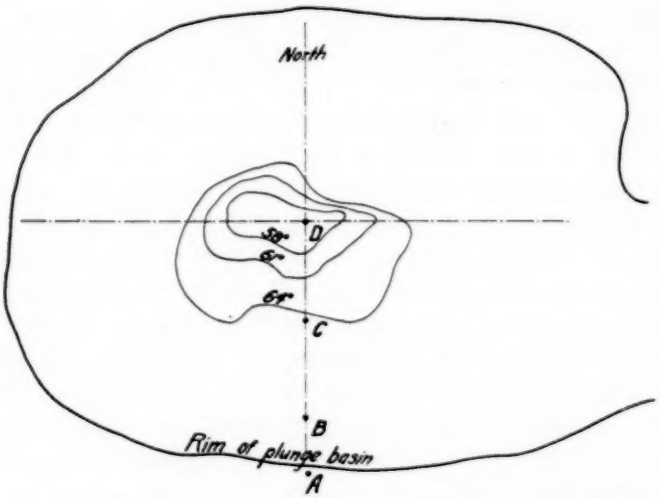

FIG. 1. Map of plunge basin, with isotherms of air temperatures (Fahr.) at 1 in. from the ground, at noon, September 12, 1916. *A*, *B*, *C* and *D* indicate location of stations referred to in the text. Scale, 1 in. = 160 ft.

Throughout this region the rock is extensively fissured and it is probable that the underlying bedrock here is traversed by crevices, since water does not collect in the basin. Except on a considerable portion of the north side, where there is a rock slide, the slopes are covered by a thin layer of nearly pure humus. Under the conditions which occur here this soil is always moist and plant growth in the basin is not restricted by lack of available water.

The basin lies in a forest which has been somewhat disturbed by cutting. The interior of the basin itself is heavily wooded with *Tilia*, *Thuja*, *Betula lutea*, etc. The outlet is a narrow notch which extends only half the depth of the basin. As a result of

these conditions, the bottom is completely free from air currents due to winds; even on a day when the local weather bureau station reported a wind velocity of thirty-five miles per hour, no movement of the air was perceptible half way down the slope of the basin. This absence of air currents is of prime significance in the explanation of the striking conditions of temperature that occur here.

Four stations for the securing of data on temperature and humidity were established in the basin. The first of these (FIG. 1, *A*) is six feet back from the rim, on the south side; it is in a forest of *Tilia* and *Acer saccharum*. The second station (*B*) is fifty feet down the slope from *A*; *Tilia*, *Scolopendrium* and *Impatiens* are the characteristic plants. Station *C* is one hundred feet further down the slope, while *D* is at the bottom of the basin, about one hundred feet below *C*. Temperature and humidity readings were made at each of these stations several times during the summer of 1916 and once during 1917; the data obtained on August 22, 1916, the hottest day of the year, are given in TABLE I.

TABLE I

TEMPERATURE AND HUMIDITY DATA AT STATIONS IN PLUNGE BASIN. AUGUST 22, 1916, 2.30–4.30 P.M.

Station	Temperatures (Fahr.)				Humidity (%)	
	3 ft. above ground	6 in. above ground	1 in. in soil	6 in. above ground	4 ft. above ground	6 in. above ground
A...	94.7	90.6	81.5	72.5	32	30
B...	90.0		76.6	75.2	32	37.5
C...	90.0	78.0	73.0	68.5	39	43
D...	63.5	59.7	51.3	42.5	73	71

The remarkable character of the conditions in the plunge basin is sufficiently shown by the data obtained at station *D*, where air temperatures were thirty degrees below those of station *A*, and where the soil temperature at a depth of six inches was only ten and one half degrees above freezing point. Readings made on other dates gave data similar to those of TABLE I, but in no case were any of the temperatures at station *D* higher than those given above. Similarly, the humidity at *D* varied from 75 to 85 per cent. but was at no time found to be below that recorded in TABLE I.

The cause of the low temperatures in the bottom of the basin

is not clear, but is probably to be found in the accumulation of ice in underlying fissures. In the basin itself ice persists in the spring about a month after it has disappeared elsewhere. It is possible that a sufficient amount of ice accumulates in large crevices or fissures under the loose rock of the basin to maintain the low temperatures through the summer season. Some such localization of the areas of lowest temperature is indicated by the data on soil temperatures given in FIG. 2.

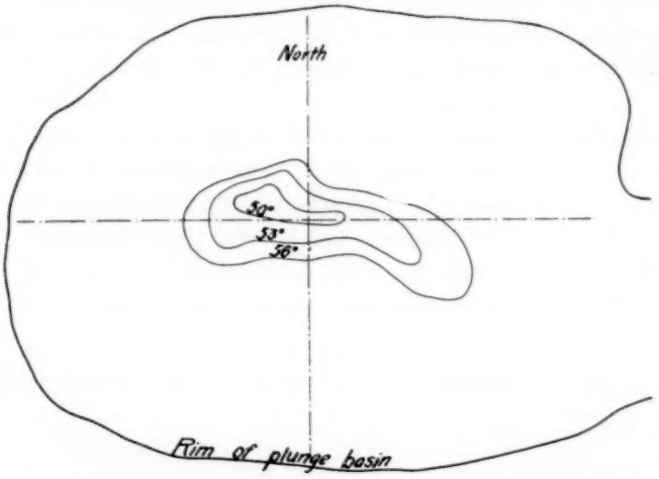

FIG. 2. Map of plunge basin with isotherms of soil temperatures (Fahr.) at depth of 1 inch at noon, September 12, 1916. Scale, 1 in. = 160 ft.

In order to determine with exactness the temperature conditions over the entire bottom of the basin, a system of twenty stations, at distances of thirty-five to fifty feet from each other, was established; these covered an irregular area extending about three hundred feet along the axis of the basin, some ninety feet up the south slope and about seventy feet up the northern slope. Two thermometers were placed at each station, one, completely shaded, at one inch from the ground, the other with the center of the bulb in the soil to a depth of one inch; after thirty minutes all the thermometers were read simultaneously.

When the temperature data are plotted on a map of the basin, isotherms can be drawn to represent the temperature conditions. FIG. 1 shows air isotherms representing the conditions existing

between 11:30 A. M. and 12 M. on September 12, 1916, when the temperature at three feet from the ground at station *A* (on the rim) was 73° F.; FIG. 2 shows the soil isotherms of the same date. These are typical of the results obtained; charts made from the data obtained on other dates show that the isotherms vary but little in shape, only moving up and down the slopes within narrow limits with changes of temperature outside the basin. When the outside temperature falls below that within the basin the system of isotherms is of course destroyed.

As mentioned, *Scolopendrium* occurs abundantly in this basin, which is a typical habitat for it, associated with *Impatiens pallida* Nutt., *Asarum canadense* L., *Rubus odoratus* L., *Aspidium marginale* (L.) Sw., *Cystopteris bulbifera* (L.) Bernh., etc.; this association is restricted to the upper third of the south slope of the basin and is therefore outside the region of very low temperatures. The greater part of the basin is occupied by an association in which *Thuja occidentalis* L., *Betula lutea* Michx. f., and *Acer spicatum* Lam. are the dominant members; ground forms are few, mostly *Cystopteris bulbifera*, *Aspidium marginale* (L.) Sw., *A. spinulosum* (O. F. Müller) Sw. var. *intermedium* (Muhl.) D. C. Eaton, and *Thuidium* spp. The tree members of this association extend to the bottom of the basin but are less abundant there than farther up the slopes.

The forest floor association of the bottom area is the striking feature of the vegetation of the basin; a list of the species follows.

DOMINANT SPECIES

Cornus canadensis L.
Lycopodium annotinum L.
Dalibarda repens L.
Coptis trifolia (L.) Salisb.
Phegopteris Dryopteris (L.) Fée.
Pyrola asarifolia Michx.
Ribes lacustre (Pers.) Poir.

INCIDENTAL SPECIES

Lycopodium lucidulum Michx.
L. obscurum L. var. *dendroideum* (Michx.) D. C. Eaton
Aspidium marginale
A. spinulosum var. *intermedium*
Aralia nudicaulis L.
Tiarella cordifolia L.
Streptopus roseus Michx.
Actaea rubra (Ait.) Willd.
Diervilla Lonicera Mill.

Of these species, Bray, in the first paper of this series, lists three of the dominant ones as indicators of the Canadian zone—characteristic of the Adirondacks above 3,500 ft.—and four others as occurring abundantly in the Canadian Transition zone—characteristic of the higher Catskills and of the Adirondacks up to 3,500 ft.; and Cooper* lists four of the dominant species as characteristic of the climax forest of Isle Royale, Lake Superior. In addition, the manuals indicate a northern distribution for all the remaining species. These citations are sufficient to indicate the distinctively northern character of the plant association of the bottom of the basin.

Without entering into a discussion of the general questions of discontinuous distribution, it is evident that this may be considered to be a typical relict association, left behind at the final recession of the ice sheet. In this interpretation, certain conditions exist in this plunge basin which have caused or permitted the maintainance here of a plant association characteristic of more northerly regions or areas of higher altitude. That low temperature is the controlling factor of these conditions is the immediate and obvious conclusion from the data given above. This conclusion is strongly supported by further analysis of conditions in the basin.

During the work in the basin it was early noticed that the characteristic species of the bottom association are restricted to a common region of limited area and irregular shape; that is, the conditions which caused or permitted the maintenance of the association in the basin exist only in a small area of its bottom. As already described, the conditions of soil moisture, humidity, wind, etc., vary but slightly within the basin and cannot be controlling factors. The growing season in the bottom area is considerably shorter than in the upper part of the basin, due to the late melting of accumulated snow; the frostless period is probably about one hundred twenty-five days—an average period for the Canadian-Transition zone of Bray. This short growing season cannot however be effective in preventing the spread of the bottom association up the slopes of the basin, for not only do most of the

* Cooper, W. S. The climax forest of Isle Royale, Lake Superior, and its development. Bot. Gaz. **55**: 1–44, 115–140, 189–235. 1913.

species of the association spread readily by vegetative propagation, but ripe spores or seeds are also produced by most of them. On the other hand, the short season cannot be effective in preventing the invasion of plants of the higher parts of the slope, since these species have a longer season in which to mature spores or seeds, and every facility for their distribution into the bottom area.

With regard to the temperature conditions, however, the case is different. Casual observation indicated that the characteristic species of the bottom association do not occur outside the region of noticeably low temperatures. To verify this observation the

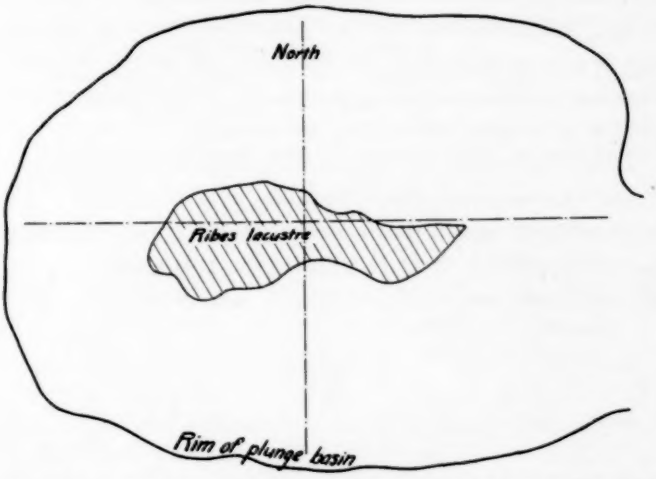

FIG. 3. Map of plunge basin showing distribution of *Ribes lacustre* (Pers.) Poir. Scale, 1 in. = 160 ft.

exact distribution within the basin of five of the dominant species was determined and plotted. The maps of the distribution areas are remarkably alike; that for *Ribes lacustre*, given in FIG. 3, is typical. By comparison with FIG. 1 it will be seen that the distribution area is only roughly that of low air temperatures, being extended farther along the axis of the basin. A comparison of FIGS. 2 and 3, however, shows a remarkable similarity between the outline of the distribution area of *Ribes* and the soil isotherm of 56° Fahr.; and the maps of the distribution areas of the other species show an equally close resemblance. This coincidence of the areas of low soil temperature and of distribution of five of the dominant

species is held to indicate a direct causal relationship between the two. The writer is of the opinion that we have here a case in which the control of distribution of a plant association by the single factor of temperature is demonstrable; and that the plunge basin offers an exceptionally favorable opportunity to determine experimentally the mechanism of this control. Work is now in progress along this line.

SUMMARY

1. In the bottoms of certain plunge basins near Syracuse, New York, low temperatures prevail throughout the year. Data of air and soil temperatures are given for one such basin whose bottom lies at an altitude of six hundred ten feet above sea level; an area of some thousands of square yards in it remains throughout the year at a temperature below 70° Fahr.

2. The bottom area of this basin is occupied by an association of plants characteristically Canadian in distribution. Analysis of the conditions in the basin demonstrates that temperature is the factor controlling their distribution in this area.

SYRACUSE UNIVERSITY,
SYRACUSE, NEW YORK

INDEX TO AMERICAN BOTANICAL LITERATURE

1912-1918

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Allard, H. A. Abnormalities in *Nicotiana*. Bot. Gaz. **65**: 175–185. *f. 1–10.* 15 F 1918.

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